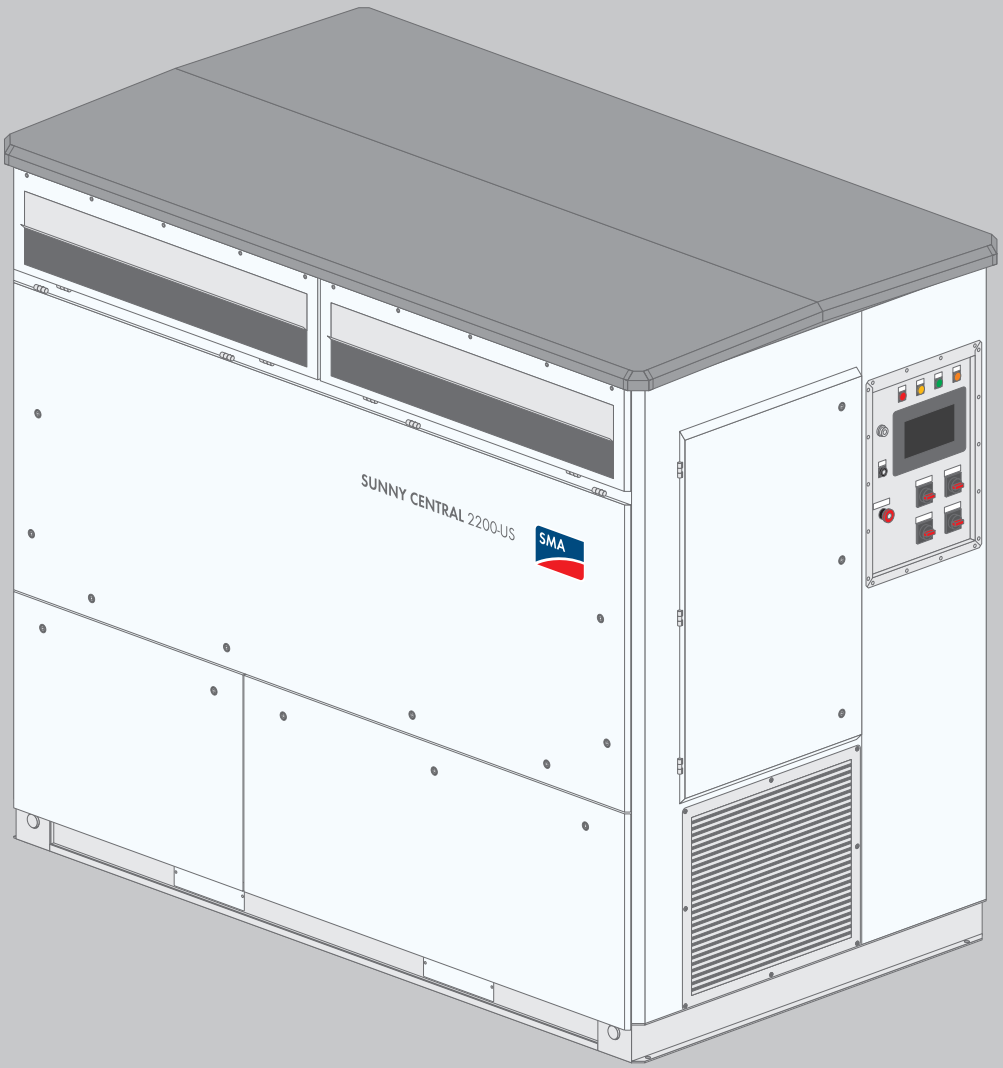
User Manual

SUNNY CENTRAL 1850-US
SUNNY CENTRAL 2200-US



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Important Safety Information

SAVE THESE INSTRUCTIONS

This manual contains important instructions for the following products:

- SC-2200-US-10 (Sunny Central 2200-US)
- SC-1850-US-10 (Sunny Central 1850-US)

This manual must be followed during installation and maintenance.

The product is designed and tested in accordance with international safety requirements, but as with all electrical and electronic equipment, certain precautions must be observed when installing and/or operating the product. To reduce the risk of personal injury and to ensure the safe installation and operation of the product, you must carefully read and follow all instructions, cautions and warnings in this manual.

Warnings in this Document

A warning describes a hazard to equipment or personnel. It calls attention to a procedure or practice, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the SMA equipment and/or other equipment connected to the SMA equipment or personal injury.

Symbol	Description
⚠ DANGER	DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.
⚠ WARNING	WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.
⚠ CAUTION	CAUTION indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
NOTICE	NOTICE is used to address practices not related to personal injury.

Warnings on this Product

The following symbols are used as product markings with the following meanings.

Beware of dangerous voltage

The product operates at high voltages. All work on the product must only be performed as described in the documentation of the product.

Electric arc hazards

The product has large electrical potential differences between its conductors. Arc flashes can occur through air when high-voltage current flows. Do not work on the product during operation.

Risk of fire

Improper installation of the product may cause a fire.

Beware of hot surface

The product can get hot during operation. Do not touch the product during operation.

Use hearing protection

The product generates loud noises. When working on the product, wear hearing protection.

Observe the operating instructions

Read the documentation of the product before working on it. Follow all safety precautions and instructions as described in the documentation.

General Warnings

⚠ WARNING

General Warnings

All electrical installations must be carried out in accordance with the local standards and the *National Electrical Code*® ANSI/NFPA 70 or the *Canadian Electrical Code*® CSA C22.1. This document does not replace and is not intended to replace any local, state, provincial, federal or national laws, regulations or codes applicable to the installation and use of the product, including without limitation applicable electrical safety codes. All installations must conform with the laws, regulations, codes and standards applicable in the jurisdiction of installation. SMA assumes no responsibility for the compliance or non-compliance with such laws or codes in connection with the installation of the product.

- Before installing or using the product, read all of the instructions, cautions, and warnings in this manual.
- Before connecting the product to the electrical utility grid, contact the local utility company. This connection must be made only by qualified personnel.
- Wiring of the product must be made by qualified personnel only.

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1 Information on this Document

1.1 Validity

This document is valid for the following device types:

Device type	Production version	Firmware version
SC-2200-US-10 (Sunny Central 2200-US)	Q4	1.02.13.R
SC-1850-US-10 (Sunny Central 1850-US)	Q4	1.02.13.R

The production version of the inverter is indicated on the type label.

The firmware version can be read off from the user interface.

Illustrations in this document are reduced to the essential and may deviate from the real product.

1.2 Target Group

The tasks described in this document must only be performed by qualified persons. Qualified persons must have the following skills:

- Knowledge of how the product works and is operated
- Training in how to deal with the dangers and risks associated with installing and using electrical devices and installations
- Training in the installation and commissioning of electrical devices and installations
- Knowledge of and adherence to this manual and all safety information
- Training in dealing with dangers and risks in electrical installations according to 29 CFR, Chapter XVII, Part 1910 (OSHA), NEC and NFPA 70E
- Training in risk prevention when working with electrical installations

1.3 Additional Information

Links to additional information can be found at www.SMA-Solar.com.

1.4 Symbols

Symbol	Explanation
	Information that is important for a specific topic or goal, but is not safety-relevant
☐	Indicates a requirement for meeting a specific goal
☑	Desired result
✖	A problem that might occur
	The description is applicable for use on the touch display.
	The description is applicable for use via Internet access.

1.5 Typographies

Typographies	Use	Example
bold	• Display messages • Elements on a user interface • Terminals • Slots • Elements to be selected • Elements to be entered	• Set parameter **WGra** to **0.2**.
>	• Connects several elements to be selected	• Select **PV system > Detect**.
[**Button/Key**]	• Button or key to be selected or pressed	• Select [**Start detection**].

1.6 Nomenclature

Complete designation	Designation in this document
Sunny Central 2200-US	Sunny Central or inverter
Sunny Central 1850-US	Sunny Central or inverter
SMA Solar Technology America LLC	SMA
SMA Solar Technology Canada Inc.	SMA

2 Safety

2.1 Intended Use

The Sunny Central is a PV inverter which converts the direct current generated in the PV modules into grid-compliant alternating current. An external MV transformer fitted downstream feeds the generated alternating current into the utility grid.

The product is designed for outdoor use only.

The inverter is classified under Class 4C2 as per IEC 60721-3-4: 1995 and is suitable for operation in a chemically active environment. The enclosure corresponds to UL 1741 "Type 3R" and can also be operated in rain, sleet and snow.

It is only permitted to use the product in a PV power plant which is designed as a closed electrical operating area as per IEC 61936-1.

The switching capacity of the AC disconnection unit with steady short-circuit current is I_{ks} =6.4 kA

The maximum DC short-circuit current is 85 kA.

The specified minimum clearances must be observed.

The required fresh-air supply must be assured. Ensure that no exhaust air of other devices is sucked in.

The maximum permissible DC input voltage of the inverter must not be exceeded.

The category of the pollution degree is PD3.

An overvoltage test according to IEEE C62.41.2 at a voltage of up to 6 kV was carried out for the inputs in the power transmission path.

An overvoltage test according to IEEE C37.90.1 at a voltage of up to 2.5 kV was carried out for the inputs in the control path.

The inverter must only be operated in conjunction with a suitable MV transformer.

The MV transformer must be designed for the voltages that arise during the pulsed mode of the inverter.

Do not switch off or adjust settings that affect grid management services without first obtaining approval from the grid operator.

Use this product only in accordance with the information provided in the enclosed documentation and with the locally applicable standards and directives. Any other application may cause personal injury or property damage.

Alterations to the product, e.g. changes or modifications, are only permitted with the express written permission of SMA. Unauthorized alterations will void guarantee and warranty claims and usually void the operating license. SMA shall not be held liable for any damage caused by such changes.

Any use of the product other than that described in the Intended Use section does not qualify as appropriate.

The enclosed documentation is an integral part of this product. Keep the documentation in a convenient place for future reference and observe all instructions contained therein.

Only persons fulfilling all of the skills for the target group are permitted to work on or with the product.

All work on the product must only be performed using appropriate tools and in compliance with the ESD protection regulations.

Suitable personal protective equipment must be worn by all persons working on or with the product.

Unauthorized persons must not operate the product and must be kept at a safe distance from the product.

The product must not be operated with open covers or doors.

The product must not be opened when it is raining or when humidity exceeds 95%.

The product must not be operated with any technical defects.

The type label must remain permanently attached to the product.

2.2 Safety Information

This section contains safety information that must be observed at all times when working on or with the product. To prevent personal injury and property damage and to ensure long-term operation of the product, read this section carefully and observe all safety information at all times.

⚠ DANGER

Danger to life due to applied voltages

High voltages are present in the live components of the product. Touching live components results in death or serious injury due to electric shock.

- Always disconnect the inverter from the power transmission path and from the control path if no voltage is required for working on the product (see Section 5.3, page 42).
- After switching off the inverter, wait at least 15 minutes before opening it to allow the capacitors to discharge completely (see Section 5.3, page 42).
- Wear suitable personal protective equipment of the corresponding hazard risk category for all work when the power transmission path is connected. The hazard risk category of the various areas of the inverter are different. The areas are identified with warning labels.
- Wear suitable personal protective equipment for all work when the control path is connected.
- Always perform all work on the product in compliance with the regulations specified in 29 CFR, Chapter XVII, Part 1910 (OSHA), NEC, and NFPA 70E.
- Do not touch any live components.
- Observe all warning messages on the product and in the documentation.
- Observe all safety information of the module manufacturer.
- The product must not be operated with open covers or doors.

⚠ DANGER

Danger to life from electric shock due to live DC cables

DC cables connected to PV modules that are exposed to light are live. Touching live cables results in death or serious injury due to electric shock.

- Wear suitable personal protective equipment of the corresponding hazard risk category for all work when the power transmission path is connected. The hazard risk category of the various areas of the inverter are different. The areas are identified with warning labels.
- Always perform all work on the product in compliance with the regulations specified in 29 CFR, Chapter XVII, Part 1910 (OSHA), NEC, and NFPA 70E.
- Prior to connecting the DC cables, ensure that the DC cables are voltage-free.

⚠ DANGER

Danger to life from electric shock due to ground fault

If a ground fault has occurred, parts of the PV power plant that are supposedly grounded may in fact be live. Touching incorrectly grounded parts of the PV power plant results in death or serious injuries from electric shock.

- Before working on the system, ensure that no ground fault is present.
- Always perform all work on the product in compliance with the regulations specified in 29 CFR, Chapter XVII, Part 1910 (OSHA), NEC, and NFPA 70E.

⚠ DANGER

Danger to life from electric shock due to damaged product

Operating a damaged product can lead to hazardous situations that result in death or serious injuries due to electric shock.

- Only operate the product when it is in a flawless technical condition and safe to operate.
- Check the product regularly for visible damage.
- Make sure that all external safety equipment is freely accessible at all times.
- Make sure that all safety equipment is in good working order.
- Wear suitable personal protective equipment of the corresponding hazard risk category for all work when the power transmission path is connected. The hazard risk category of the various areas of the inverter are different. The areas are identified with warning labels.
- Wear suitable personal protective equipment for all work when the control path is connected.
- Always perform all work on the product in compliance with the regulations specified in 29 CFR, Chapter XVII, Part 1910 (OSHA), NEC, and NFPA 70E.

⚠ WARNING

Danger to life from electric shock if the product is not locked

If the product is not locked, unauthorized persons will have access to live components carrying lethal voltages. Touching live components can result in death or serious injury due to electric shock.

- Always close and lock the product.
- Ensure that no unauthorized person has access to the closed electrical operating area.

⚠ WARNING

Risk of fire due to failure to observe torque specifications on live bolted connections

Failure to follow the specified torques reduces the ampacity of live bolted connections so that the contact resistances increase. This can cause components to overheat and catch fire.

- Ensure that live bolted connections are always tightened with the exact torque specified in this document.
- When working on the device, use suitable tools only.
- Avoid repeated tightening of live bolted connections as this may result in inadmissibly high torques.

⚠ WARNING

Danger to life from electric shock when entering the PV field

The ground-fault monitoring with GFDI, Remote GFDI does not provide protection from personal injury when the ground-fault monitoring is activated. PV modules which are grounded with ground-fault monitoring discharge voltage to ground. Entering the PV field can result in lethal electric shocks.

- Ensure that the insulation resistance of the PV field exceeds the minimum value. The minimum value of the insulation resistance is: 550 Ω.
- Before entering the PV field, switch the PV modules to insulated operation.
- Configure the PV power plant as a closed electrical operating area.

⚠ WARNING

Hearing impairment due to high-frequency noises of the inverter

The inverter generates high-frequency noises when in operation. This can result in hearing impairment.

- Wear personal protective equipment for all work on the product.
- Wear hearing protection.

⚠ CAUTION

Risk of burns due to hot components

Some components of the product can get very hot during operation. Touching these components can cause burns.

- Observe the warnings on all components.
- During operation, do not touch any components marked with such warnings.
- After switching off the product, wait until any hot components have cooled down sufficiently.
- Wear suitable personal protective equipment for all work on the product.

⚠ CAUTION

Danger of crushing and collision when carelessly working on the product

Carelessly working on the product could result in crushing injuries or collisions with edges.

- Wear personal protective equipment for all work on the product.

⚠ CAUTION

Risk of injury when using unsuitable tools

Using unsuitable tools can result in injuries.

- Ensure that the tools are suitable for the work to be carried out.
- Wear personal protective equipment for all work on the product.

NOTICE

Property damage due to dust intrusion and moisture penetration

Dust or moisture intrusion can damage the product and impair its functionality.

- Do not open the enclosure during rainfall or when humidity exceeds the specified thresholds. The humidity thresholds are: 0 % ... 95 %.
- Only perform maintenance work when the environment is dry and free of dust.
- Only operate the product when it is closed.
- If the installation or commissioning process is interrupted, mount all panels.
- Close and lock the enclosure.
- The product must always be closed for storage.
- Store the product in a dry and covered location.
- Temperature at the storage location must be in the specified range. The temperature range is: –40 °C ... +70 °C (–40 °F ... +158 °F).

NOTICE

Damage to electronic components due to electrostatic discharge

Electrostatic discharge can damage or destroy electronic components.

- Observe the ESD safety regulations when working on the product.
- Wear suitable personal protective equipment for all work on the product.
- Discharge electrostatic charge by touching grounded enclosure parts or other grounded elements. Only then is it safe to touch electronic components.

2.3 Personal Protective Equipment

Always wear suitable protective equipment

When working on the product, always wear the appropriate personal protective equipment for the specific job.

All clothing should be in accordance with NFPA 70E Section 130.7. Appropriately insulated gloves for shock protection in accordance with NFPA 70E Section 130.7(C), rated at least 1,000 V shall be worn as required.

Any other prescribed protective equipment must also be used. When carrying out work on live parts of the inverter, wear protective equipment of the respective Hazard Risk Category in accordance with NEMA NFPA 70 E, table 130.7(C)(16). The hazard risk category of the various areas of the inverter are different. The areas are identified with warning labels.

Personal protective equipment required

Appropriate arc flash hazard labels stating the required personal protective equipment (PPE) for exposed, energized interaction with the equipment, are attached. SMA has conducted an electric arc risk analysis in accordance with NFPA 70E. Appropriate arc flash hazard labels are attached. The required personal protective equipment (PPE) for exposed, energized interaction with the equipment is indicated on the labels. PPE is required for all routine maintenance, diagnostics, and commissioning activities as described in the SMA protocols. Areas within the machine also exist that cannot, under any circumstances, be exposed while energized. These areas are marked accordingly on the machine, and can only be made accessible after de-energization of the inverter.

For further information, contact us (see Section 13, page 111).

3 Product Overview

3.1 Design of the inverter

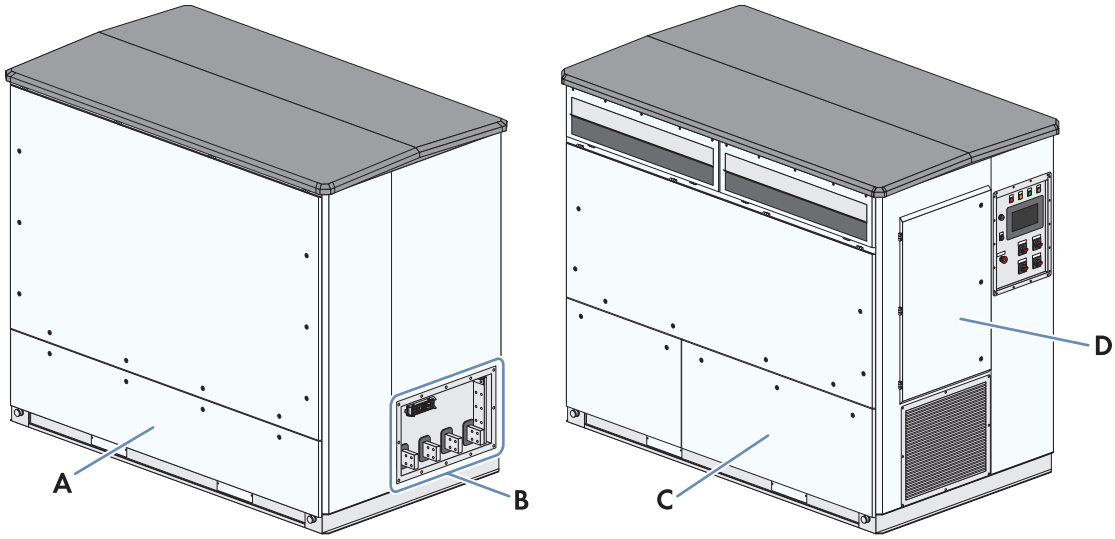


Figure 1: Design of the Inverter

Position	Designation
A	DC connection area and grounding
B	AC connection area and grounding
C	Connection area for electronics
D	Customer installation location

3.2 Devices of the Inverter

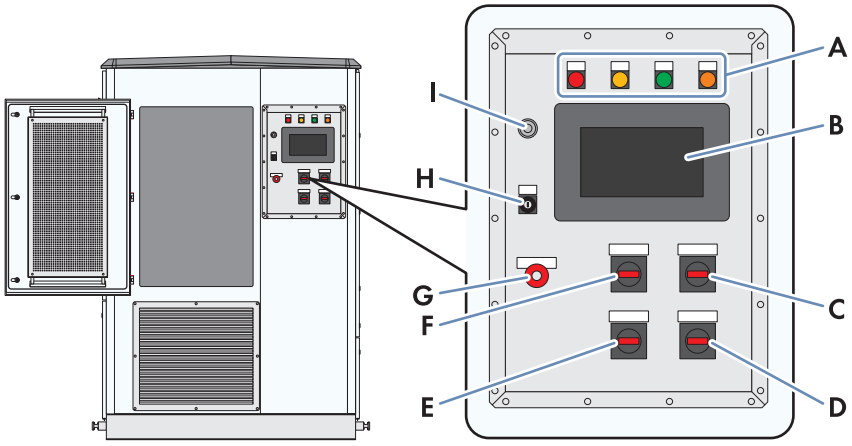


Figure 2: Devices of the inverter

Position	Designation
A	Light repeater **-P1**, **-P2**, **-P3**, **-P4**
B	Touch display **-A60**
C	Load-break switch **-Q63** for AC disconnection unit

Position	Designation
D	Load-break switch **-Q64** for auxiliary energy supply*
E	Load-break switch **-Q62** for supply voltage
F	Load-break switch **-Q61** for DC switchgear
G	Key switch **-S2** for fast stop
H	Key switch **-S1** for start/stop
I	Service interface**-X500**

* only for option "Auxiliary supply for external loads: 2.5 kVA/230 V" or "Auxiliary supply for external loads: 2.5 kVA/120 V"

3.3 Operating and Display Elements

3.3.1 Function of the Switches

3.3.1.1 Start/Stop Key Switch -S1

"Start" switch position

If the key switch is set to **Start**, the inverter switches from the "Stop" operating state to the "WaitAC" operating state. If the utility grid is valid, the inverter switches on the AC disconnection unit and changes the inverter to the "WaitDC" operating state. If the irradiation is sufficient, the inverter connects the DCV switchgear and changes to the "GridFeed" operating state. If the irradiation is insufficient and the input voltage is therefore too low, the DC switchgear remains open and the inverter remains in the "WaitDC" state.

"Stop" switch position

If the key switch is turned to **Stop** while the inverter is in the "WaitDC" operating state, the inverter switches to the "Stop" operating state and the AC disconnection unit is switched off.

If the key switch is turned to **Stop** while the inverter is in the "GridFeed" operating state, the inverter switches to the "RampDown" operating state. Once shutdown is complete, the AC disconnection unit and the DC switchgear are switched off automatically and the inverter switches to the operating state "Stop".

3.3.1.2 Fast-Stop Key Switch -S2

When the key switch is actuated, the inverter disconnects from the utility grid in under 100 ms.

The supply voltage and the optional additional auxiliary power supply remain connected so that the inverter can continue to be accessed.

Actuation of the fast-stop key switch -S2

The fast-stop key switch **-S2** should only be tripped in case of imminent danger. Tripping of the fast stop does not entail fast discharge of the capacitors. If the inverter is to be switched off and properly shut down via an external signal, the external start/stop function **-X433** should be used.

3.3.1.3 Load-Break Switch for DC Disconnection Unit -Q61

The load-break switch switches the motor drive of the DC switchgears **-Q21** to **-Q23** on or off. In addition, the following devices are switched on or off:

- Switch-cabinet heater **-E1**
- Heaters for low-temperature option **-E2** to **-E4**
- Inverter bridge fans **-G1**

- Switch cabinet fans **-G10** and **-G11**

3.3.1.4 Load-Break Switch for Supply Voltage -Q62

The load-break switch switches the supply voltage for the following devices on or off:

- Switch-cabinet heater **-E1**
- Heaters for low-temperature option **-E2** to **-E4**
- Inverter bridge fans **-G1**
- Switch cabinet fans **-G10** and **-G11**
- Power metering **-A41**
- Service interface **-X500**
- Customer slot **-X310**
- Assemblies **-A50** and **-A1**
- Communication unit **-A3**
- Touch display **-A60**

3.3.1.5 Load-Break Switch for AC Switchgear and Precharge Unit -Q63

The load-break switch switches the following devices on or off:

- precharge unit **-Q50**
- AC switchgear **-Q1**

3.3.1.6 Load-Break Switch -Q64 for Auxiliary Energy Supply

3.3.2 Light Repeaters

3.3.2.1 Light repeater at the control panel

Light repeater status		Designation	Explanation
	Red: glowing Yellow: glowing Green: glowing	Initialization	The inverter is now in the initialization phase. A light repeater test is performed.
	Red: off Yellow: off Green: glowing	Feed-in operation	The inverter is feeding into the utility grid.
	Red: off Yellow: flashing Green: glowing	Restricted feed-in operation	Due to external derating or temperature derating, the inverter is feeding into the utility grid at reduced power.
	Red: off Yellow: flashing Green: flashing	Grid limit monitoring with restricted feed-in operation	The inverter is monitoring the utility grid and the required delay time has not yet expired. Currently, external or temperature derating is active.
	Red: off Yellow: glowing Green: glowing	Feed-in operation with warning	The inverter continues to feed into the utility grid, but a warning is pending.

Light repeater status		Designation	Explanation
	Red: off Yellow: off Green: flashing	Grid limit monitoring	The inverter is monitoring the utility grid and the required delay time has not yet expired.
	Red: off Yellow: glowing Green: off	Warning	The inverter is currently not feeding power into the grid and has detected a warning. As soon as the warning is no longer pending, it will be automatically reset.
	Red: off Yellow: flashing Green: off	Limited feed-in operation possible	The inverter could feed into the utility grid at reduced power, but external or temperature derating is active.
	Red: glowing Yellow: off Green: off	Disturbance	The inverter has detected a disturbance and switched off.
	Red: off Yellow: off Green: off	Waiting for DC voltage	The inverter waits until the DC voltage reaches set thresholds so that it can start grid feed-in. The inverter is in the operating state "Shutdown".
	Red: flashing Yellow: flashing Green: flashing	Light repeater test	The inverter is in the state "Test mode" and the test for the light repeaters has been selected.
	Orange: flashing	GFDI light repeater	The inverter has detected a ground fault.

3.3.3 Touch Display

On the touch display, you can display and configure parameters, instantaneous values, diagrams and maintenance intervals via the user interface. Any disturbances which have occurred can be displayed on the user interface and measures for their elimination can be initiated.

The user interface is basically structured in the same way for both touch display and Internet access.

3.4 Symbols on the Product

The following gives an explanation of all the symbols found on the inverter and on the type label.

Symbol	Designation	Explanation
	Direct current	–
	Alternating current	–
	Protection class I	All electrical equipment is connected to the grounding conductor system of the product.
	Center of gravity marking	–

Symbol	Designation	Explanation
	On-setting of the AC disconnection unit	–
	Off-setting of the AC disconnection unit	–

4 User Interface

4.1 Design of the User Interface

The user interface can be controlled via the touch display on the inverter or via Internet access. The user interface is basically structured in the same way for both touch display and Internet access.

On the user interface, it is possible to display and configure parameters, instantaneous values and diagrams. Any disturbances which have occurred can be displayed on the user interface and measures for their elimination can be initiated.

Tapping the symbols on the touch display activates the respective functions.

The user interface is divided into several areas.

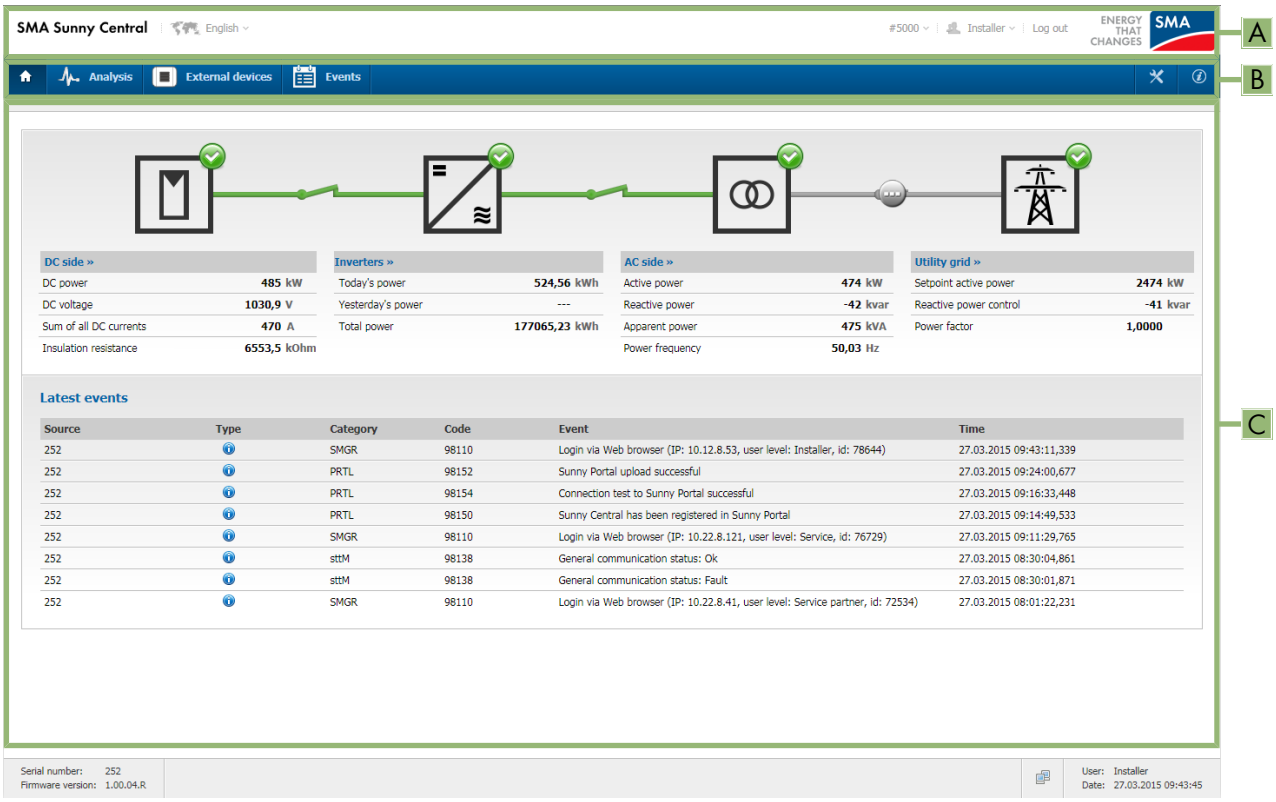

SMA Sunny Central
English
#5000
Installer
Log out
ENERGY THAT CHANGES
SMA
A
Analysis
External devices
Events
B
DC side »
DC power 485 kW
DC voltage 1030,9 V
Sum of all DC currents 470 A
Insulation resistance 6553,5 kOhm
Inverters »
Today's power 524,56 kWh
Yesterday's power ---
Total power 177065,23 kWh
AC side »
Active power 474 kW
Reactive power -42 kvar
Apparent power 475 kVA
Power frequency 50,03 Hz
Utility grid »
Setpoint active power 2474 kW
Reactive power control -41 kvar
Power factor 1,0000
Latest events
Source Type Category Code Event Time
252 SMGR 98110 Login via Web browser (IP: 10.12.8.53, user level: Installer, id: 78644) 27.03.2015 09:43:11,339
252 PRTL 98152 Sunny Portal upload successful 27.03.2015 09:24:00,677
252 PRTL 98154 Connection test to Sunny Portal successful 27.03.2015 09:16:33,448
252 PRTL 98150 Sunny Central has been registered in Sunny Portal 27.03.2015 09:14:49,533
252 SMGR 98110 Login via Web browser (IP: 10.22.8.121, user level: Service, id: 76729) 27.03.2015 09:11:29,765
252 sttM 98138 General communication status: Ok 27.03.2015 08:30:04,861
252 sttM 98138 General communication status: Fault 27.03.2015 08:30:01,871
252 SMGR 98110 Login via Web browser (IP: 10.22.8.41, user level: Service partner, id: 72534) 27.03.2015 08:01:22,231
C
Serial number: 252
Firmware version: 1.00.04.R
User: Installer
Date: 27.03.2015 09:43:45

Figure 3: Design of the user interface (example: Internet access)

Position	Designation	Explanation
A	Status info line	Settings for language as well as quick navigation and password input. Settings for brightness and the time
B	Main navigation	Navigation area The main navigation bar is located on the right margin of the user interface. The main navigation bar is located on the upper margin of the user interface.
C	Content area	Data overview depending on the selected menu

4.2 Explanation of Symbols

Status info line

Symbol	Designation	Description
	Language selection	- - In addition to the language selection, a dialog for localization of the user interface is available.
	Brightness setting	- - The brightness settings can only be made on the touch display.
	Time display	- - The time settings can only be made on the touch display.
	Navigation aid	Each view, parameter and instantaneous value is assigned a unique number. Using the quick navigation, you can enter the desired number. The user interface then switches direct to the corresponding page. Navigation via these numbers is mainly used for the coordination of several users working simultaneously on the inverter. Using the same page number, each user will see the same screen.
	Log in	Login as user, installer, service partner or SMA Service with password entry. The number of silhouettes visible indicates how many users are logged into the user interface. In the list of possible users, the number of users logged in for each role is displayed. The role **User** is always logged in.

Main navigation

The selected menu item is color-highlighted.

Symbol	Designation	Description
	Arrow buttons	The left arrow takes you back one page at a time if several pages are already activated. Once you have gone back at least one page, the right arrow is activated and will take you forward one page at a time. To navigate to the previous or next page, use the arrow buttons of the web browser.
	Home	Fast overview of system status For each component of the PV power plant, the key instantaneous values and the status of the assemblies and switches are displayed.

Symbol	Designation	Description
	Analysis	Switches to the analysis area of the user interface(see Section 4.4, page 26) Detailed information on the following areas: • DC side • Inverter • AC side • Utility grid • Instantaneous values • Detailed analysis
	External devices	Overview of the connected external devices (see Section 4.5, page 33)
	Events	Display of all saved events (see Section 4.6, page 33). The events can be filtered.
	Configuration	Configuration options for: • Instantaneous values (see Section 4.4.7, page 30) • Parameters (see Section 4.7.1, page 34) • Import and export of parameters, settings and measured values In addition, the setup assistant can be used here to carry out the parameter configuration for specific applications in a step-by-step process.
	Information	Important data for identification of the system

Contents Area

Symbol	Designation
	DC Side
	Inverter
	MV transformer
	Utility grid
	Switch closed
	Switch open

Symbol	Designation
	Switching status unknown
	Device running / status OK
	Device is not running / fault
	Device status unknown

4.3 Home Page

The **Home** page gives you a first overview of the status of the system. This includes the DC side, the inverter, the AC side and the utility grid.

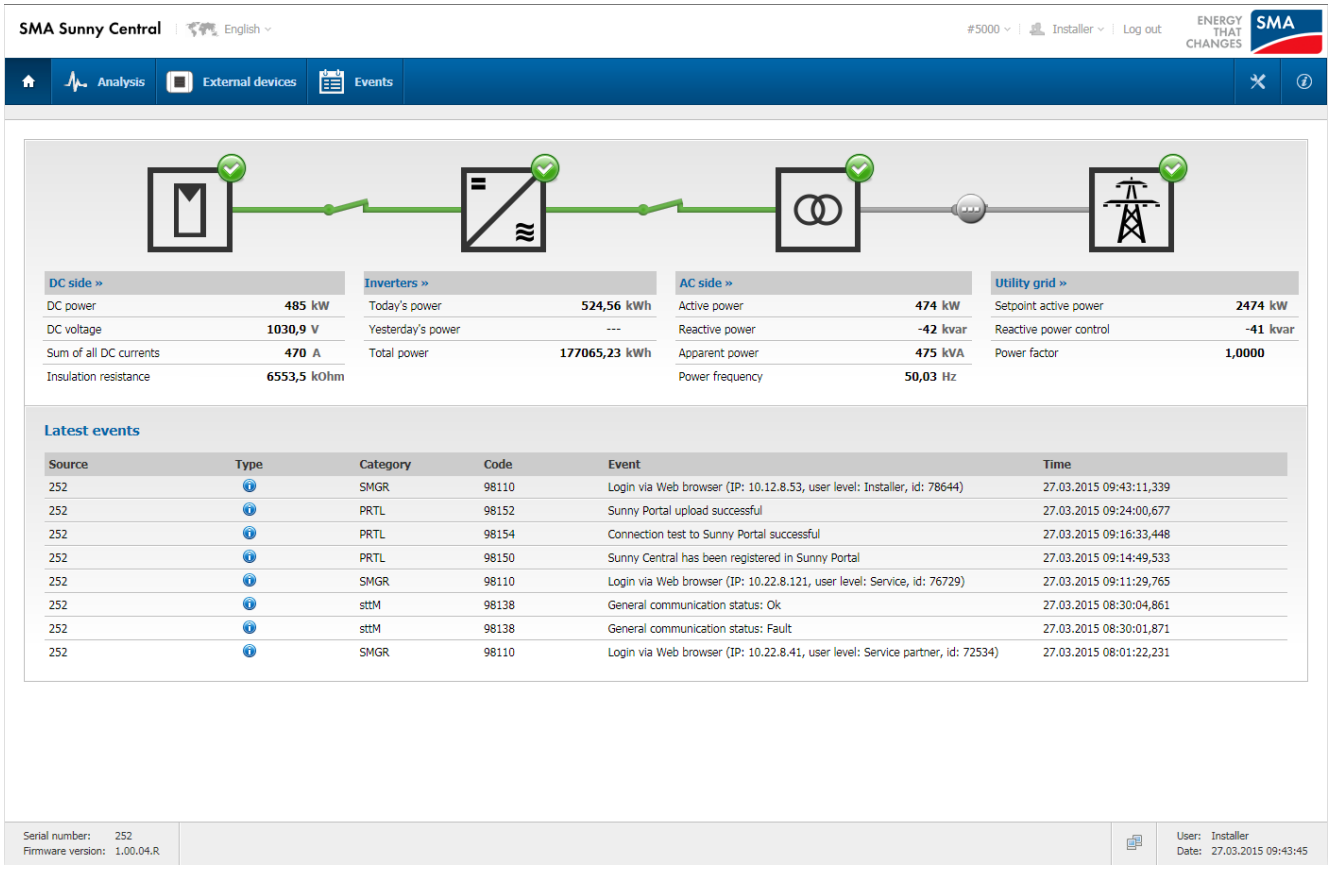

SMA Sunny Central
English
#5000
Installer
Log out
ENERGY THAT CHANGES
SMA
Analysis
External devices
Events
DC side »
DC power 485 kW
DC voltage 1030,9 V
Sum of all DC currents 470 A
Insulation resistance 6553,5 kOhm
Inverters »
Today's power 524,56 kWh
Yesterday's power ---
Total power 177065,23 kWh
AC side »
Active power 474 kW
Reactive power -42 kvar
Apparent power 475 kVA
Power frequency 50,03 Hz
Utility grid »
Setpoint active power 2474 kW
Reactive power control -41 kvar
Power factor 1,0000
Latest events
Source Type Category Code Event Time
252 SMGR 98110 Login via Web browser (IP: 10.12.8.53, user level: Installer, id: 78644) 27.03.2015 09:43:11,339
252 PRTL 98152 Sunny Portal upload successful 27.03.2015 09:24:00,677
252 PRTL 98154 Connection test to Sunny Portal successful 27.03.2015 09:16:33,448
252 PRTL 98150 Sunny Central has been registered in Sunny Portal 27.03.2015 09:14:49,533
252 SMGR 98110 Login via Web browser (IP: 10.22.8.121, user level: Service, id: 76729) 27.03.2015 09:11:29,765
252 sttM 98138 General communication status: Ok 27.03.2015 08:30:04,861
252 sttM 98138 General communication status: Fault 27.03.2015 08:30:01,871
252 SMGR 98110 Login via Web browser (IP: 10.22.8.41, user level: Service partner, id: 72534) 27.03.2015 08:01:22,231
Serial number: 252
Firmware version: 1.00.04.R
User: Installer
Date: 27.03.2015 09:43:45

Figure 4: Page **Home** of the user interface

Each component of the PV system is displayed by a symbol in the block circuit diagram. The status of each component of the PV system is indicated by a symbol. Under each symbol, the key instantaneous values of that system component are displayed. The status of the switches between the components of the PV system is indicated by the corresponding switch symbols (see Section 4.2, page 23). If there are several switches between the individual components, a closed switch is displayed as soon as at least one of the switches is closed.

If you select the button of a particular component, e.g. [**DC side**], the corresponding analysis page opens (see Section 4.4, page 26).

Depending on the user role of the person logged in, differing information will be displayed in the bottom section of the user interface:

User view

In addition to the instantaneous values relevant to the components of the PV system, the AC power of the inverter over the last 24 hours is depicted in a diagram. The diagram can be enlarged to full-screen view.

Installer view

Apart from the instantaneous values of the PV system components, a list of the last eight events is displayed. To open the event list, select **Latest events** (see Section 4.6, page 33).

4.4 Analysis

4.4.1 Structure of the Analysis Pages

The Analysis pages consist of an analysis menu and the menu-dependent content area.

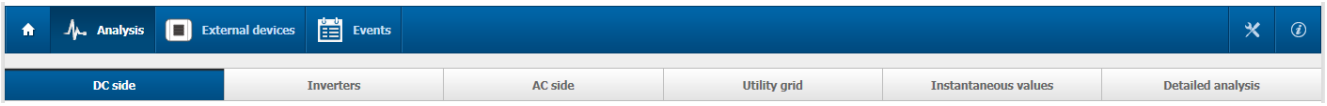


Figure 5: Menu of the page **Analysis** on the user interface

The menu items **Instantaneous values** and **Detail analysis** are only available to the Installer and will not be visible to the User.

4.4.2 Diagrams on the Analysis Pages

On the analysis pages **DC side**, **Inverter**, **AC side** and **Utility grid**, there is a diagram in the bottom half of the content area. In the diagrams, you can select and display the relevant data. Here, it is possible to select different display periods.

In each diagram there are two Y axes available for the representation of the data. This enables instantaneous values with two different physical units to be displayed in the same diagram. You can allocate any number of instantaneous values with the same physical unit to each of the Y axes. In this case, the horizontal grid lines in the diagram are always drawn corresponding to the labelling of the two Y axes.

You can see which instantaneous value is allocated to which curve by the legend.

If you move the mouse pointer over the diagram, the detail values of each curve are shown in a legend window. As soon as you take the mouse pointer off the content area of the diagram, the legend window is hidden.

4.4.3 DC Side

The content area of the page **DC side** is subdivided into four sections.

Figure 6: Page **DC side** of the user interface (example)

Position	Description
A	Overview of the status of the PV array and the inverter as well as the switch positions of the DC side, as detail of the block diagram on the Home page
B	Depiction of the current DC power
C	Display of current voltage, electrical current strength and insulation resistance on the DC side of the inverter
D	Diagram with display of instantaneous values for DC voltage, DC power, DC current strength and interior temperature of the inverter

4.4.4 Inverter

The content area of the page **Inverter** is subdivided into four sections.

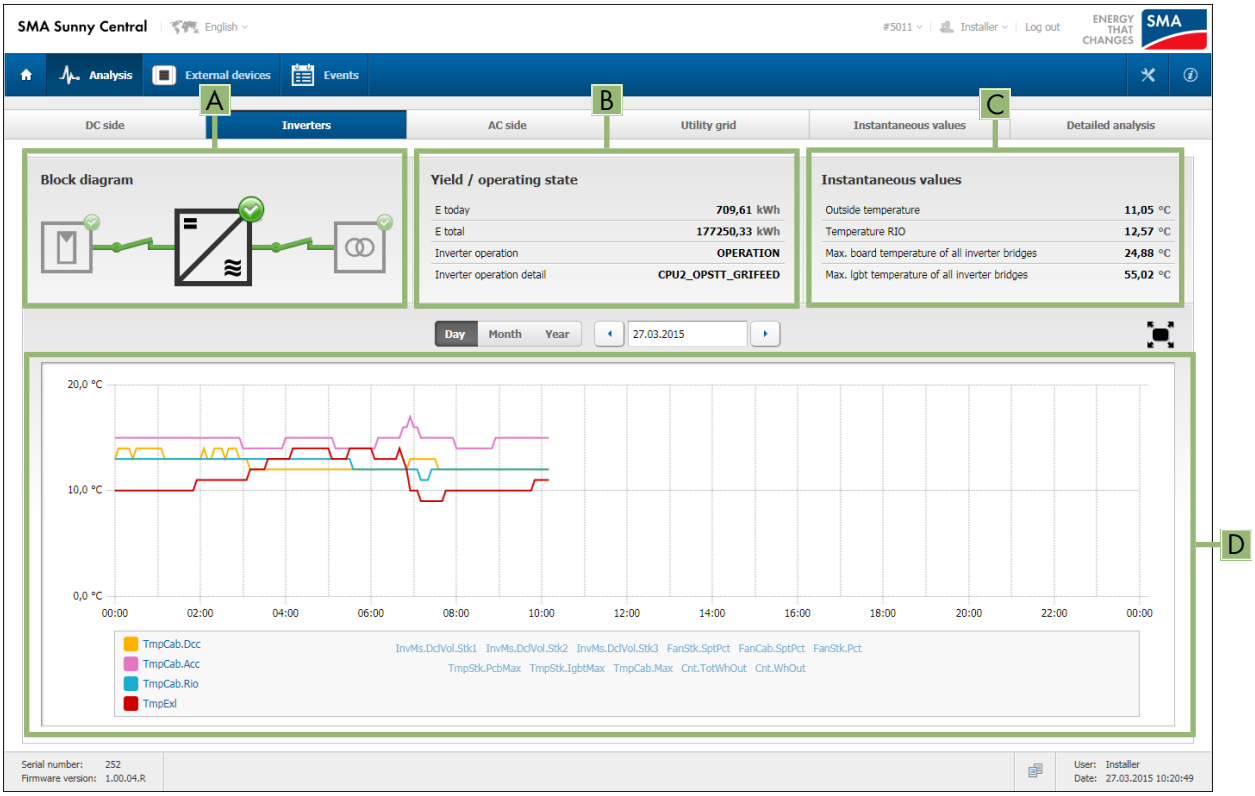


Figure 7: **Inverter page** of the user interface (example)

Position	Description
A	Overview of the status of the PV array, the inverter and the MV transformer, as well as the switch positions of the DC and AC sides, as detail of the block diagram on the Home page The inverter is highlighted.
B	Display of the energy fed in on the current day, the total energy fed in and the operating state of the inverter
C	Display of the current temperature inside the inverter and of the environment
D	Diagram with instantaneous values for ambient temperature and interior temperature of the inverter

4.4.5 AC Side

The content ion the page **AC side** is subdivided into four sections.

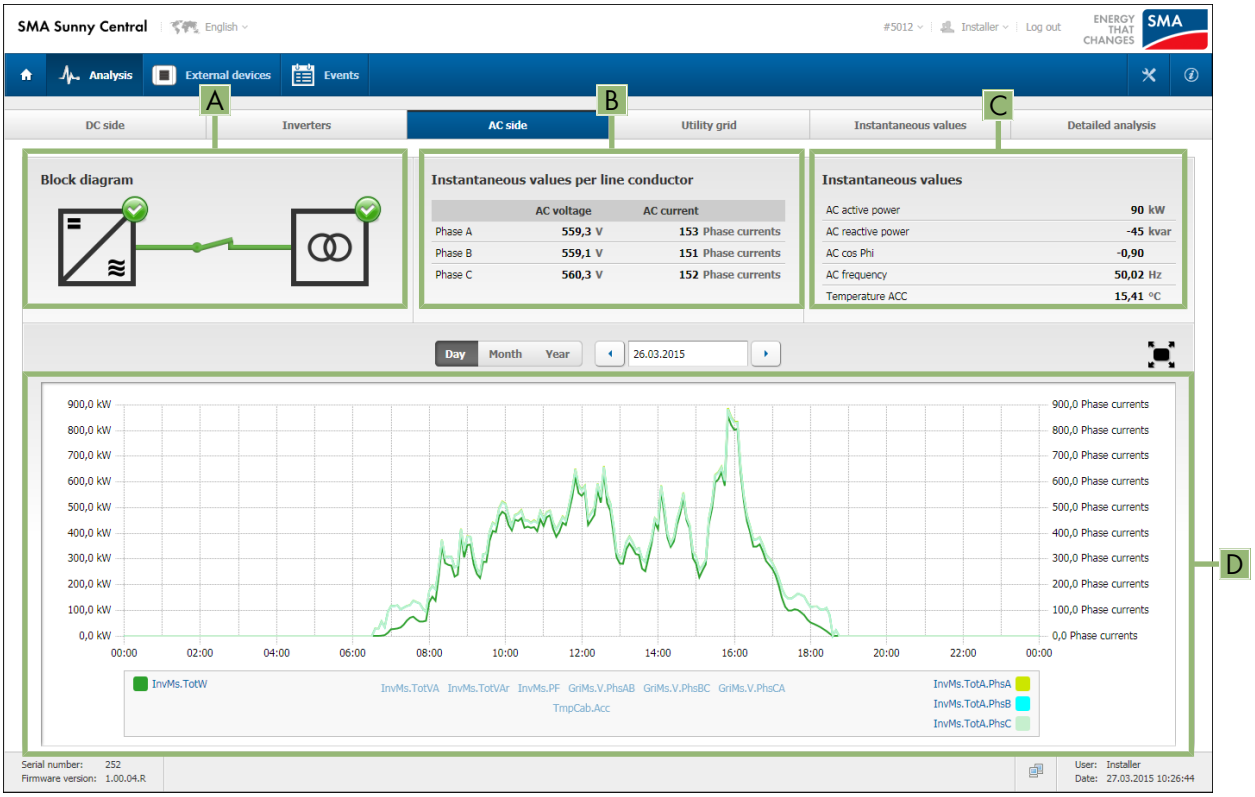


Figure 8: Page **AC side** of the user interface (example)

Position	Description
A	Overview of the status of the inverter and the MV transformer as well as the switch positions of the AC side, as detail of the block diagram on the Home page.
B	Display of the current voltage and electrical current strength on the AC side for each line conductor
C	Display of the current active power, reactive power, apparent power and frequency of the utility grid
D	Diagram with instantaneous values Here you can choose data groups with two physical units from the instantaneous values for voltage and current strength of each line conductor, the instantaneous active, reactive and apparent power, and the power frequency.

4.4.6 Utility Grid

The content area of the page **Utility grid** is subdivided into four sections.

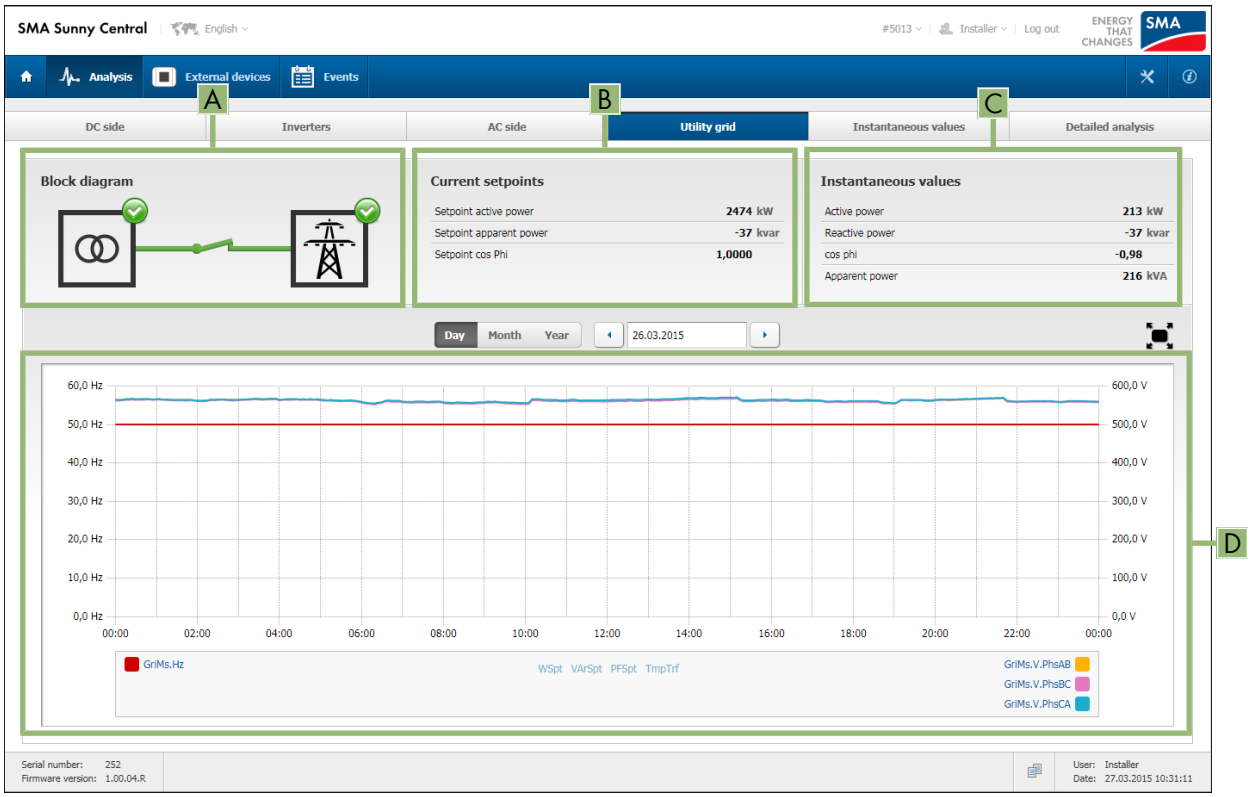


Figure 9: Page **Utility grid** of the user interface (example)

Position	Description
A	Overview of the status of the MV transformer and the utility grid as well as the switch positions of connections to the utility grid, as detail of the block diagram on the Home page.
B	Display of the current setpoints for active and reactive power
C	Display of the current active power, reactive power and apparent power
D	Diagram with instantaneous values Here you can choose data groups with two physical units from the instantaneous values for voltage and current strength of each line conductor, the instantaneous active, reactive and apparent power, and the power frequency.

4.4.7 Instantaneous Values

The number of available instantaneous values depends on the role for which you are logged in.

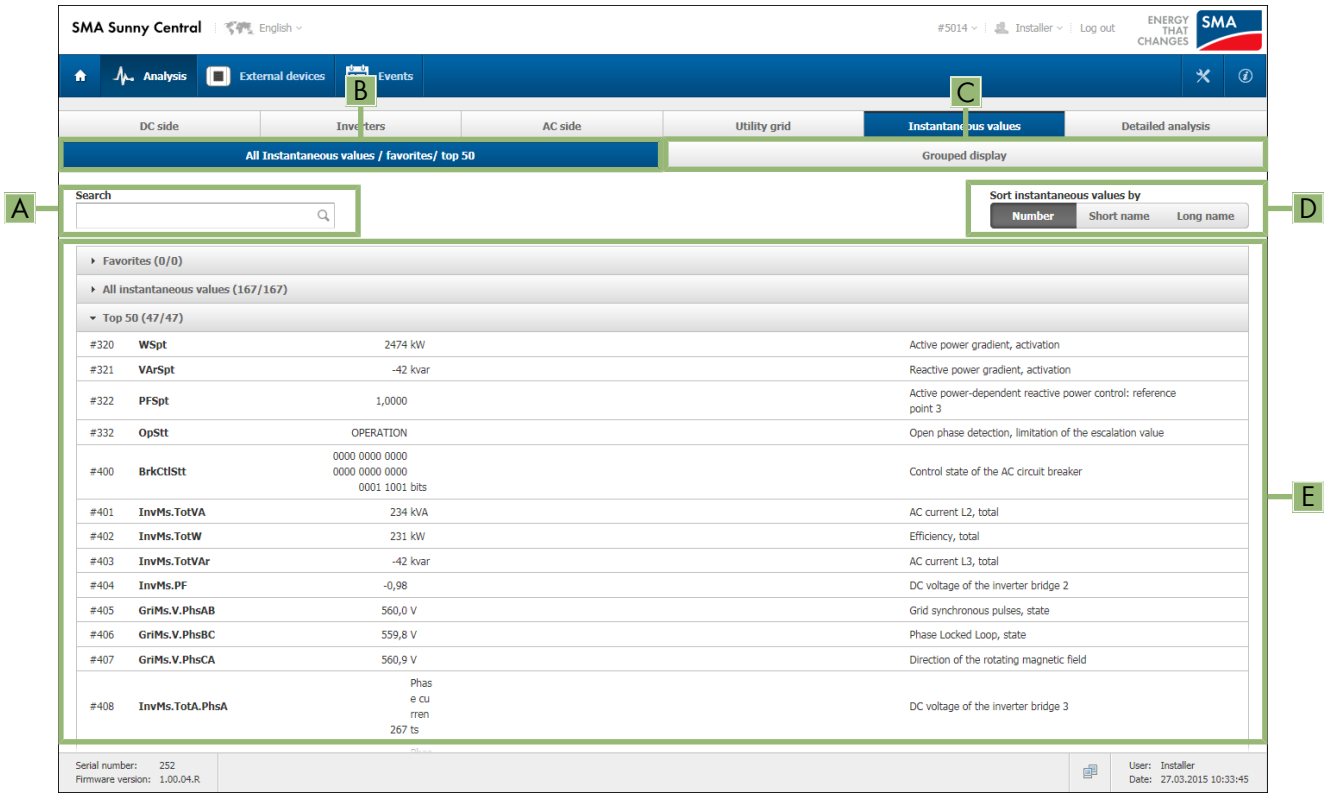

SMA Sunny Central
English
#5014
Installer
Log out
ENERGY THAT CHANGES
SMA
Analysis
External devices
Events
B
C
DC side
Inverters
AC side
Utility grid
Instantaneous values
Detailed analysis
All instantaneous values / favorites/ top 50
Grouped display
A
Search
Sort instantaneous values by
Number
Short name
Long name
D
Favorites (0/0)
All instantaneous values (167/167)
Top 50 (47/47)
#320 WSpt 2474 kW Active power gradient, activation
#321 VArSpt -42 kvar Reactive power gradient, activation
#322 PFSpt 1,0000 Active power-dependent reactive power control: reference point 3
#332 OpStt OPERATION Open phase detection, limitation of the escalation value
#400 BrkCtlStt 0000 0000 0000 0000 0000 0000 0001 1001 bits Control state of the AC circuit breaker
#401 InvMs.TotVA 234 kVA AC current L2, total
#402 InvMs.TotW 231 kW Efficiency, total
#403 InvMs.TotVAr -42 kvar AC current L3, total
#404 InvMs.PF -0,98 DC voltage of the inverter bridge 2
#405 GriMs.V.PhsAB 560,0 V Grid synchronous pulses, state
#406 GriMs.V.PhsBC 559,8 V Phase Locked Loop, state
#407 GriMs.V.PhsCA 560,9 V Direction of the rotating magnetic field
#408 InvMs.TotA.PhsA Phase current 267 ts DC voltage of the inverter bridge 3
E
Serial number: 252
Firmware version: 1.00.04.R
User: Installer
Date: 27.03.2015 10:33:45

Figure 10: Page **Instantaneous values** of the user interface (example)

Position	Description
A	Search field for targeted search of instantaneous values. The search function refers to the long and short names. You can search for the numbers of the instantaneous values in the status info line.
B	Display of instantaneous values **All instantaneous values**, a list with user-defined **Favorites** or a pre-defined list of the **Top 50** instantaneous values can be displayed.
C	Display of grouped instantaneous values and parameters Instantaneous values and parameters are grouped under various headings. It is possible that certain instantaneous values are allocated to several groups.
D	Sorting of the instantaneous values and parameters according to the long and short names by which they are designated in this document, and by their number. Sorting takes place by lines, the columns always remain in the same order.
E	Overview of instantaneous values Depending on your selection, a list with instantaneous values or the categories of grouped data organized in a tree structure will appear. If you hover the cursor over the list, a star appears at the end of the line. By clicking on the star, you can mark this instantaneous value for inclusion in **Favorites**. If you select a line in the list, a star appears at the end of the line. Click the star to mark this instantaneous value for inclusion in **Favorites**.

At the lowest navigation level, the instantaneous values are represented in a table. Values which have changed since the last page update are highlighted.

If you select a particular instantaneous value, a detailed view for that value opens.

Detailed View of Instantaneous Values

You can activate a detailed view for each instantaneous value. In the detailed view, the instantaneous value is displayed in a separate, strongly magnified window. This enables the value to be read off from a distance, e.g., during maintenance work.

You can open several detailed views simultaneously. The window size can be adjusted and the windows can be arranged at random on the screen.

4.4.8 Detailed Analysis

In the detailed analysis, the recorded instantaneous values can be represented in the diagram over various time periods.

The number of available instantaneous values depends on the role for which you are logged in.

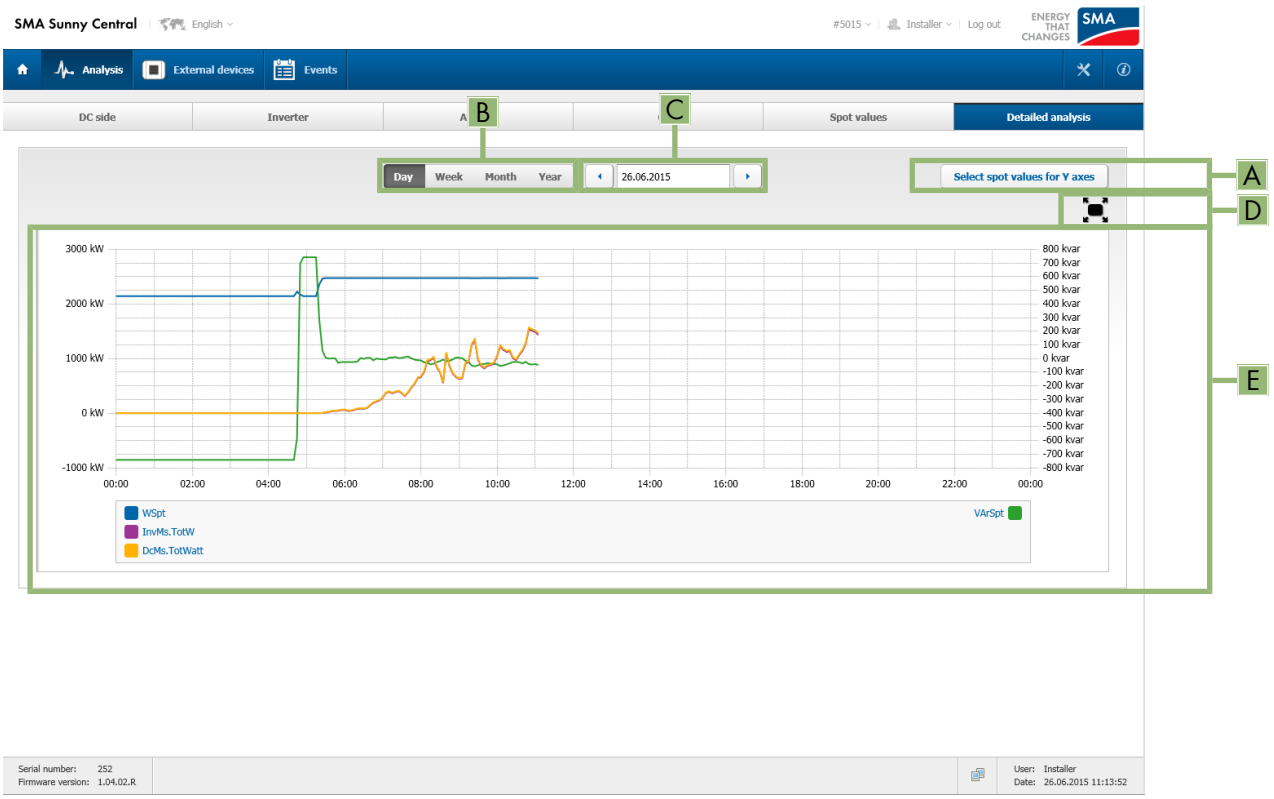


Figure 11: Page **Detail analysis** of the user interface (example)

Position	Explanation
A	Allocation of instantaneous values to the two Y axes Any number of instantaneous values having the same physical unit can be allocated to each of the Y axes. If instantaneous values have been allocated to each Y axis and a further instantaneous value with a third physical unit is selected, an error message is generated.
B	Selection of the displayed time period • Day - Display of the selected day from 00:00 a.m. to 11:59 p.m. • Month - Display of the selected month Dates are always displayed from 1 to 31 to avoid any confusion. • Year - Display of the selected year

Position	Explanation
C	Selecting the period to be displayed You can select the date or the time period either by using the arrow buttons next to the date field or by making a direct entry in the date field.
D	Enlarging the diagram to full screen If you move the mouse pointer over the diagram, the detail values of each curve are shown in a legend window. As soon as you take the mouse pointer or your finger off the content area of the diagram, the legend window is hidden.
E	Representation of the selected instantaneous values in the diagram You can see which instantaneous value is allocated to which curve by the legend. The displayed instantaneous values can be deactivated by clicking the instantaneous values in the legend.

4.5 External Devices

On the page **External devices**, all connected external devices are shown in a list. The IP address, SuSYID and device name are displayed for each external device.

Select an external device to display the corresponding parameters and instantaneous values. When this is done, the parameters and instantaneous values can be filtered by the targeted search.

4.6 Events

All events and disturbances which have occurred are listed in the Events list.

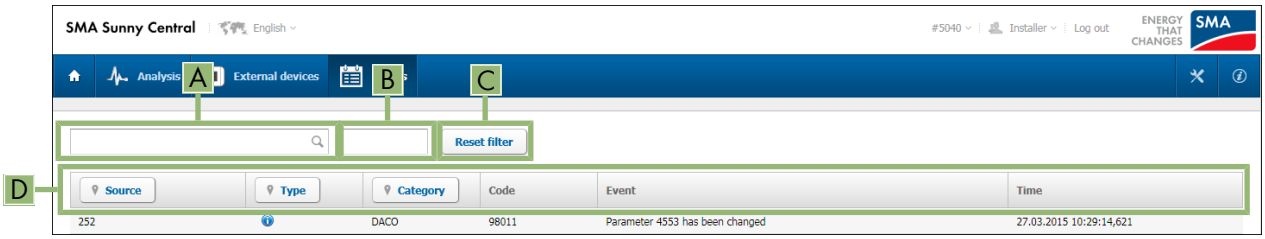


Figure 12: Events dialog

Position	Explanation
A	Search field for targeted search of events. The search function refers to the column **Event**.
B	Selection of the day the events of which are to be displayed in the center of the list. The list continues above and below this central area.

Position	Explanation
C	Reset of the filter configured in the event list
D	List of events For each event, the following information is displayed: • **Source** - Indication of the device in which the event was generated • **Type** - The event type is represented by symbols. • **Category** - Detailed localization of the event at the given source • **Code** - The event number serves as an orientation aid for Service. • **Event** - Description of the event • **Time** - Time of occurrence of the event

The type of event can be recognized by the displayed symbol:

Symbol	Explanation
	An event of subordinate priority, e.g. a parameter change or user login, has occurred in the inverter. Events of this type do not influence feed-in operation.
	A warning has occurred in the inverter. Warnings do not influence the inverter feed-in operation. The cause of the warning must be remedied.
	An error has occurred in the inverter. Feed-in operation of the inverter is interrupted. The cause of the error must be remedied and the error acknowledged.
	Incoming event; the cause is still present
	Going event; the cause is no longer present

4.7 Configuration Options

4.7.1 Parameters

The **Parameter** page can only be viewed if you are logged in as an installer.

On the Parameters page those parameters can be changed which are accessible to the currently logged-in user. The parameters are displayed in various constellations.

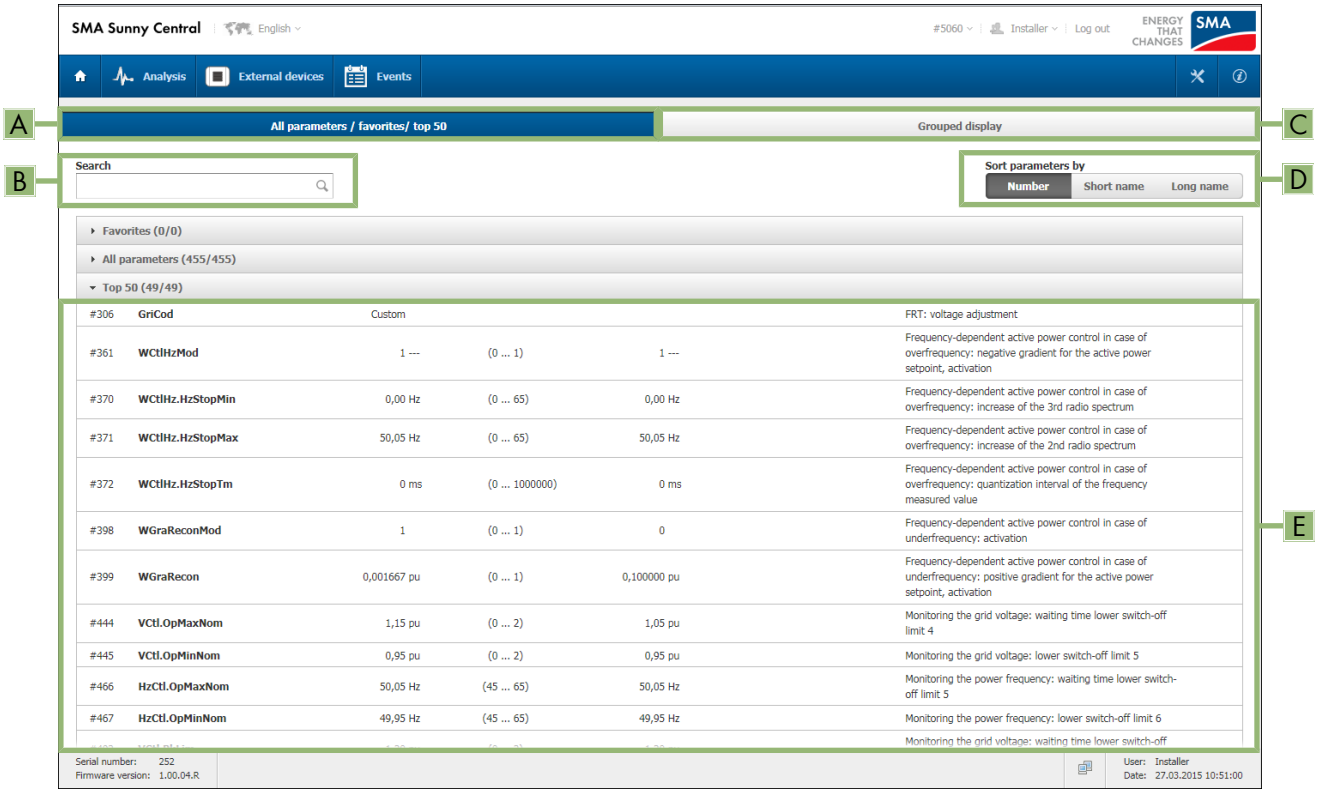

SMA Sunny Central
English
#5060
Installer
Log out
ENERGY THAT CHANGES
SMA
Analysis
External devices
Events
A
All parameters / favorites/ top 50
Grouped display
C
B
Search
Sort parameters by
Number
Short name
Long name
D
Favorites (0/0)
All parameters (455/455)
Top 50 (49/49)
#306 GriCod Custom FRT: voltage adjustment
#361 WCtlHzMod 1 --- (0 ... 1) 1 --- Frequency-dependent active power control in case of overfrequency: negative gradient for the active power setpoint, activation
#370 WCtlHz.HzStopMin 0,00 Hz (0 ... 65) 0,00 Hz Frequency-dependent active power control in case of overfrequency: increase of the 3rd radio spectrum
#371 WCtlHz.HzStopMax 50,05 Hz (0 ... 65) 50,05 Hz Frequency-dependent active power control in case of overfrequency: increase of the 2nd radio spectrum
#372 WCtlHz.HzStopTm 0 ms (0 ... 1000000) 0 ms Frequency-dependent active power control in case of overfrequency: quantization interval of the frequency measured value
#398 WGraReconMod 1 (0 ... 1) 0 Frequency-dependent active power control in case of underfrequency: activation
#399 WGraRecon 0,001667 pu (0 ... 1) 0,100000 pu Frequency-dependent active power control in case of underfrequency: positive gradient for the active power setpoint, activation
#444 VCtl.OpMaxNom 1,15 pu (0 ... 2) 1,05 pu Monitoring the grid voltage: waiting time lower switch-off limit 4
#445 VCtl.OpMinNom 0,95 pu (0 ... 2) 0,95 pu Monitoring the grid voltage: lower switch-off limit 5
#466 HzCtl.OpMaxNom 50,05 Hz (45 ... 65) 50,05 Hz Monitoring the power frequency: waiting time lower switch-off limit 5
#467 HzCtl.OpMinNom 49,95 Hz (45 ... 65) 49,95 Hz Monitoring the power frequency: lower switch-off limit 6
E
Serial number: 252
Firmware version: 1.00.04.R
User: Installer
Date: 27.03.2015 10:51:00

Figure 13: Page **Parameters** of the user interface

Position	Explanation
A	Display of parameter lists **All parameters**, a list with user-defined **Favorites** or a pre-defined list of the **Top 50** parameters can be displayed.
B	Search field for the targeted search of parameters. The search function refers to the long and short names. You can search for the numbers of the parameters in the status info line. The search function is not available for the grouped parameters.
C	Display of grouped parameters The parameters are grouped by default under various headings. It is possible that certain parameters are allocated to several groups.

Position	Explanation
D	Sorting of the parameters according to their long and short names as designated in this document, and by number. Sorting takes place by lines, the columns always remain in the same order. The sort function is not available for the grouped parameters.
E	Parameter overview Depending on the display type selected, a list with parameters or the categories of grouped parameters organized in a tree structure will appear. For each parameter, the short name, number, set value, unit, possible configuration range, long name and favorite status are displayed. You can activate a parameter by clicking on the line. If you possess write privileges for the given parameter, an input field or drop-down list will open. In the entry field of an activated parameter, the favorite identifier can be activated. At the end of the line a star appears by activated parameters. By clicking on the star, you can mark this parameter to include it in **Favorites**. Once the parameter change is saved, a check mark appears in the line. This check mark is displayed until the next logout. If a parameter change has not been saved, a red "X" appears in the line and an error message appears above the input field. In this case, the parameter is still highlighted. The parameter will only revert to an inactive state when the parameter has been changed successfully or the change has been canceled.

4.7.2 Update

One update package each is brought to the inverter for a firmware update. This update package contains updates for the individual assemblies of the inverter. When updating, there is not a new version for the individual assemblies in every update, so that the assemblies can have different version statuses.

The currently installed firmware version is displayed for the **Installer** user group on the update page.

For this, the version number of the installed update package is specified in the **Update version** column and the firmware version of the respective assembly is in the **Current version** column.

4.7.3 Import

4.7.3.1 Import Concept

If you are logged in as the installer, you have the option of importing various data sets:

Data type	Explanation
Favorites	Import of favorite lists of instantaneous values and parameters
Modbus profile	Import of Modbus profiles
Parameters and settings	Import of parameters. The parameter file can contain the entire parameter list including IP addresses of the inverter, the entire parameter list excluding IP addresses of the inverter, or individual parameters.

File imports are performed via a menu dialog in the web browser via which you can select a file saved on the computer.

File imports are performed from a storage medium connected to the communication interface, e.g. a USB flash drive.

In the first step of the import function, the selected import file is uploaded to the internal cache. In the second step, the import file can be imported from the internal cache to the given application or deleted from the internal cache. If you do not delete the file, it will be retained in the internal memory and can be used as a backup copy.

4.7.3.2 Structure of the Import Page

On the page **import**, the data types that can be imported are displayed. Once you have selected the type of file to be imported, a page opens in which you can select the file to be imported.

4.7.4 Export

4.7.4.1 Export Concept

You have the option of exporting various data sets:

Data type	Explanation
Picture recordings of the local UI	Export of the screenshots created on the touch display
Event log files	Export of the user-role-specific events for a selected time period
Favorites	Export of the list of favorites. The settings assigned to the favorites are not exported.
Modbus profiles	Export of Modbus profiles
Parameters and settings	Export of parameters and their assigned settings. Here, different formats can be selected: • Cloning: The parameters and settings are exported without the IP address of the inverter. • All: All parameters and settings are exported. • Selection: The specific parameters to be exported can be selected from a list.
System log files	Export of operating system-specific data

In the first step of the export process, an export file is generated from the selected data. The export file is written to the internal cache and the size of the generated file is displayed on the user interface. In the second step, the export file can be downloaded from the internal cache or deleted. If you do not delete the file, it will be retained in the internal memory and can be used as a backup copy.

4.7.4.2 Structure of the Export Page

On the page **Export**, the data types that can be exported are displayed. Once you have selected the type of file to be exported, a page opens in which you can select the file to be exported.

4.7.5 File Manager

The saved files from the inverter are listed on the **File manager** page. The following information is shown to you for each file:

Designation	Explanation
Source	Event information that was saved in the file. The following events are possible: WEBLOG: Log file of the web server SYSLOG: LINUX system log file TRANSFER: Uploaded files in the internal cache EVENTLOG: Protocol of the events that have occurred INVERTERLOG: Recorded measuring data LICENSE: License file MODBUS: Modbus profile of the individual devices UPDATE: Update file FAVORITES: List of the saved favorites PARIMEX: Imported and exported parameter lists
File name	Name of the file
Date changed	Time point of the last change to the file
File size	Size of the created file

You can save or delete individual files. When saving, you have the possibility to save the files on an external storage medium or to download them onto the computer. Deletion is recommended so that the inverter's internal storage will always have enough space for the files to be saved. When deleting, it is ensured that system-relevant files are not deleted.

4.7.6 Setup Assistant

4.7.6.1 Concept of the Setup Assistants

The setup assistants support the user in performing certain procedures, e.g. commissioning. They enable you to make the necessary configurations in a step-by-step process. This ensures that all the parameters required for the given procedure can be set.

You can choose the required assistant from a list of available setup assistants. Once you have chosen the appropriate setup assistant, the overview page opens.

You need to perform each consecutive step given in the setup assistant. It is also possible to return to previously executed steps without canceling the entries you have already made. On the last page of the setup assistant, all entries are again displayed in a summary. The entries can only be saved when all steps have been executed. It is possible to exit the setup assistant after each step. Any entries made up to this point will not be implemented.

4.7.6.2 General Setup Assistant

In the General Setup Assistant you can enter the system time and the network addresses, and make localization settings.

The overview page of the General Setup Assistant provides a summary of the steps to be performed:

1. **Time** - Input of time, date and time zone. After this step, the entries are immediately saved and the inverter operates with the configured time.

2. **Name** - Input of a name for the inverter
3. **Localization** - Definition of display formats for time, date, thousands separator, decimal separator and the first day of the week
4. **Network setting LAN 2** - Input of the network configuration for the LAN 2 interface and the optional managed switch Note: On the LAN 1, the network parameters are permanently set and cannot be configured.
5. **Network setting LAN 3** - Input of the network configuration for the LAN 3 interface
6. **Summary** - Display of all entries made Any fields in which changes have been made are color-highlighted. Apart from the settings in **Step 1**, it is possible to change all entries.

4.8 Information

In the dialog box **Information**, the key data for identification of the inverter is displayed. This includes inverter-relevant and network-relevant information.

The license texts of the Open Source Elements used for this product can be downloaded via a link.

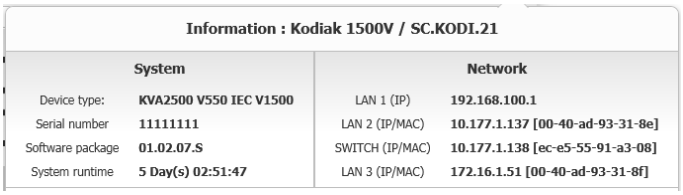


Figure 14: Dialog box **Information** (example)

5 Disconnecting and Reconnecting

5.1 Safety When Disconnecting and Reconnecting Voltage Sources

⚠ DANGER

Danger to life due to applied voltages

High voltages are present in the live components of the product. Touching live components results in death or serious injury due to electric shock.

- Always disconnect the inverter from the power transmission path and from the control path if no voltage is required for working on the product (see Section 5.3, page 42).
- After switching off the inverter, wait at least 15 minutes before opening it to allow the capacitors to discharge completely (see Section 5.3, page 42).
- Wear suitable personal protective equipment of the corresponding hazard risk category for all work when the power transmission path is connected. The hazard risk category of the various areas of the inverter are different. The areas are identified with warning labels.
- Wear suitable personal protective equipment for all work when the control path is connected.
- Always perform all work on the product in compliance with the regulations specified in 29 CFR, Chapter XVII, Part 1910 (OSHA), NEC, and NFPA 70E.
- Do not touch any live components.
- Observe all warning messages on the product and in the documentation.
- Observe all safety information of the module manufacturer.
- The product must not be operated with open covers or doors.

⚠ DANGER

Danger to life due to electric arcs if measuring device is not connected correctly

If the measurement points are incorrectly contacted, this can cause an electric arc. Electric arcs can result in death or serious injury.

- Select the appropriate measurement range on the measuring device.
- Wear suitable personal protective equipment for all work on the device.
- Select correct measurement points.

⚠ WARNING

Danger to life due to electric arc if there are tools inside the product

When reconnecting or during operation, an electric arc can occur if there are tools in the product creating a conductive connection between the live components. This can result in death or serious injury.

- Before commissioning or reconnection, verify that no tools are inside the product.

⚠ WARNING

Hearing impairment due to high-frequency noises of the inverter

The inverter generates high-frequency noises when in operation. This can result in hearing impairment.

- Wear personal protective equipment for all work on the product.
- Wear hearing protection.

⚠ CAUTION

Risk of burns due to hot components

Some components of the product can get very hot during operation. Touching these components can cause burns.

- Observe the warnings on all components.
- During operation, do not touch any components marked with such warnings.
- After switching off the product, wait until any hot components have cooled down sufficiently.
- Wear suitable personal protective equipment for all work on the product.

5.2 Disconnecting Procedures

Components that are in contact with the voltage of the PV array or with the AC voltage generated by the inverter up to the medium-voltage grid, are called "power transmission path".

Components that are in contact with supply voltages and control signals are called "control path".

Areas on the inverter

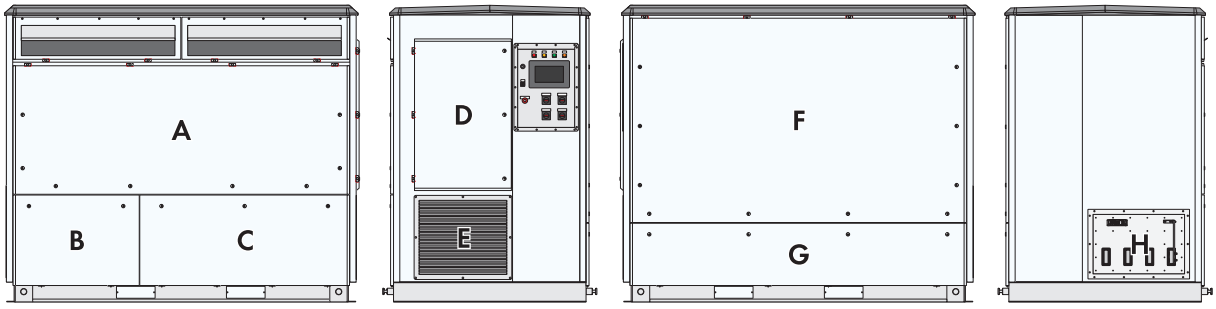


Figure 15: Areas on the inverter

Areas on the inverter	Disconnecting the power transmission path, see Section	Disconnecting the control path, see Section
A	Section 5.3.2, page 42	Section 5.3.4, page 44
B	Section 5.4, page 45	Section 5.4, page 45
C	Section 5.3.2, page 42	Section 5.3.4, page 44
D	There is no power transmission path in this area	Section 5.3.4, page 44
E	Section 5.3.2, page 42	Section 5.3.4, page 44
F	Section 5.3.3, page 43	Section 5.3.4, page 44
G	Section 5.3.3, page 43	There is no control path in this area
H	Section 5.4, page 45	Section 5.4, page 45

Hazard risk category after disconnecting the power transmission path

After disconnecting the power transmission path, the hazard risk category decreases for the respective area in the inverter. The hazard risk category is 0 after proper disconnection.

5.3 Disconnecting the Inverter

5.3.1 Switching off the Inverter

1. Turn the key switch **-S1** to **Stop**.
2. Remove the key. This will protect the inverter from inadvertent reconnection.

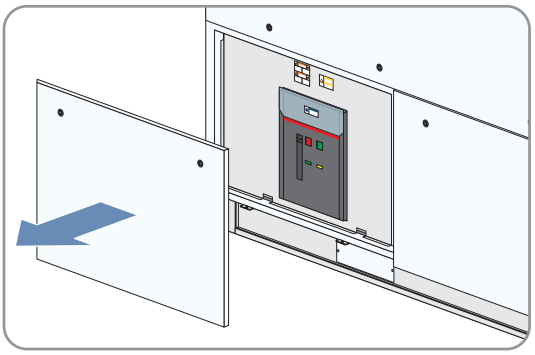
5.3.2 Disconnecting the Inverter from the Power Transmission Path on the AC Side

Additionally required material (not included in the scope of delivery):

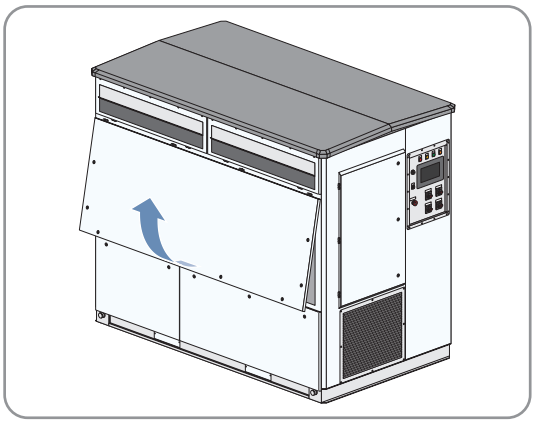
☐ 1 padlock. Diameter of the shackle: 5 mm to 8 mm (0.2 in to 0.3 in).

Procedure:

1. Make sure that the panels on the inverter are mounted correctly (see Section 9.1.1, page 65).
2. Make sure that the protective cover of the AC connection busbars is mounted correctly.
3. Switch off the inverter (see Section 5.3.1, page 42).
4. Turn the load-break switch of the AC disconnection unit and of the precharge unit **-Q63** to the **OFF** position.
5. Pull the brackets out of the switch levers.
6. Hook a suitable padlock into the bracket and lock it. This will ensure that the switch lever cannot reconnect inadvertently.
7. Disassemble the outer panel of the AC switch module (see Section 9.1.1, page 65).



8. Verify that the switch state display of the AC disconnection unit is in the **OPEN** position.
9. Mount the outer panel of the AC switch module (see Section 9.1.1, page 65).
10. Open the hatch (see Section 9.2, page 69).



11. Remove the protective cover situated above the **-X9510** terminals (see Section 9.1.2, page 67).
12. Ensure that no voltage is present on the **-X9510** terminals.

5.3.3 Disconnecting the Inverter from the Power Transmission Path on the DC Side

For inverters without DC switch in front of the input fuses

Select this procedure if the inverter is equipped with one of the following options:

- DC input configuration: none (busbar)
- DC input configuration: 9 fused inputs
- DC input configuration: 12 fused inputs
- DC input configuration: 18 fused inputs
- DC input configuration: 21 fused inputs
- DC input configuration: 24 fused inputs

Additionally required material (not included in the scope of delivery):

☐ 1 padlock. Diameter of the shackle: 5 mm to 8 mm (0.2 in to 0.3 in).

Procedure:

1. Switch off the inverter (see Section 5.3.1, page 42).
2. Turn the load-break switch of the DC switchgear **-Q61** to the **OFF** position. Note that the cable to the load-break switch is still energized.
3. Pull the bracket out of the switch lever.
4. Hook a suitable padlock into the bracket and lock it. This will ensure that the switch lever cannot reconnect inadvertently.
5. Actuate upstream switchpoint. Remove the fuses from the String-Combiners or switch off the circuit breakers of the String-Combiners.
6. Check whether the switch on the touch display between the DC side and the inverter is open and the voltage display shows 0 V.

   If the switch between the DC side and the inverter is closed or the voltage display does not show 0 V, make sure that all switch points upstream the String-Combiners have been activated. Remove the fuses from the String-Combiners or switch off the circuit breakers of the String-Combiners.
7. Open the hatch (see Section 9.2, page 69).
8. Ensure that no voltage is present for each DC input. Use the measuring points on the bottom of the fuse holders. Tip: There are drill holes in the protective covers over the fuse holders. Through these drill holes you can determine the voltage-free status with suitable test probes without having to disassemble the protective covers.

For inverters with DC switch in front of the input fuses

Select this procedure if the inverter is equipped with one of the following options:

- DC input configuration: 24 fused inputs + disco.
- DC input configuration: 28 fused inputs + disco.
- DC input configuration: 32 fused inputs + disco.

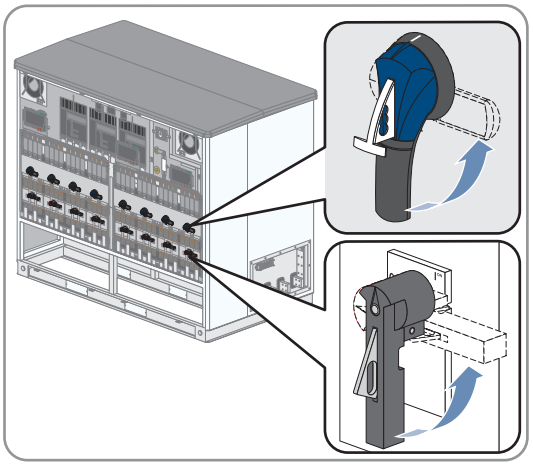
Additionally required material (not included in the scope of delivery):

☐ 17 padlocks. Diameter of the shackle: 5 mm to 8 mm (0.2 in to 0.3 in)

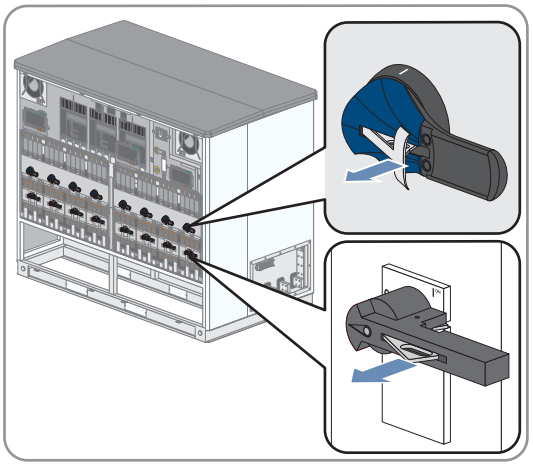
Procedure:

1. Switch off the inverter (see Section 5.3.1, page 42).
2. Turn the DC load-break switch **-Q61** to the **OFF** position. Note that the cable to the load-break switch is still energized.

3. Pull the bracket out of the switch lever.
4. Hook a suitable padlock into the bracket and lock it. This will ensure that the switch lever cannot reconnect inadvertently.
5. Open the hatch (see Section 9.2, page 69).
6. Switch all switch levers of the DC switches **-Q111 to -Q114**, **-Q121 to -Q124**, **-Q211 to -Q214**, **–Q221 to -Q224** to the **OFF** position.



7. Pull the brackets out of the switch levers.



8. Hook the padlocks in the brackets and lock them. This will ensure that the switch levers cannot reconnect inadvertently.

   ☑ The ungrounded pole of the DC inputs is activated starting at the DC switches.
9. If the ungrounded pole, the DC switches and the DC connection area should also be activated, operate the switch-point positioned in front. Remove the fuses from the String-Combiners or switch off the circuit breakers of the String-Combiners.
10. Check whether the switch between the DC side and the inverter is open on the touch display.

    If the switch between the DC side and the inverter is closed, ensure that all switch-points upstream the String-Combiners have been activated. Remove the fuses from the String-Combiners or switch off the circuit breakers of the String-Combiners.
11. Ensure that no voltage is present for each DC input. Use the measuring points on the bottom of the fuse holders. Tip: There are drill holes in the protective covers over the fuse holders. Through these drill holes you can determine the voltage-free status with suitable test probes without having to disassemble the protective covers.

5.3.4 Disconnecting the Supply Voltage and External Voltages

Additionally required material (not included in the scope of delivery):

☐ 4 padlocks. Diameter of the shackle: 5 mm to 8 mm (0.2 in to 0.3 in)

Switching Off the Supply Voltage

1. Switch off the inverter (see Section 5.3.1, page 42)
2. Turn the load-break switch for the supply voltage **-Q62** to the **OFF** position. Note that the cable to the load-break switch is still energized.
3. Pull the bracket out of the switch lever.
4. Hook a suitable padlock into the bracket and lock it. This will ensure that the switch lever cannot reconnect inadvertently.

Switching Off the Auxiliary Energy Supply

1. Turn the optional load-break switch of the auxiliary energy supply **-Q64** to the **OFF** position. Note that the cable to the load-break switch is still energized.
2. Pull the bracket out of the switch lever.
3. Hook a suitable padlock into the bracket and lock it. This will ensure that the switch lever cannot reconnect inadvertently.

Switching Off the Precharge Unit und AC Disconnection Unit

1. Switch off the inverter (see Section 5.3.1, page 42)
2. Turn the load-break switch of the AC disconnection unit **-Q63** to the **OFF** position. Note that the cable to the load-break switch is still energized.
3. Pull the bracket out of the switch lever.
4. Hook a suitable padlock into the bracket and lock it. This will ensure that the switch lever cannot reconnect inadvertently.

Switching off the Fans, Heating Elements, String Monitoring and DC Switchgear

1. Switch off the inverter (see Section 5.3.1, page 42)
2. Turn the load-break switch of the DC switchgear **-Q61** to the **OFF** position. Note that the cable to the load-break switch is still energized.
3. Pull the bracket out of the switch lever.
4. Hook a suitable padlock into the bracket and lock it. This will ensure that the switch lever cannot reconnect inadvertently.

5.4 Switching Off the MV Transformer

i Connecting and disconnecting the AC voltage

Only a duly authorized person trained in electrical safety is allowed to connect and disconnect the AC voltage.

Additionally required material (not included in the scope of delivery):

☐ 1 padlock. Diameter of the shackle: 5 mm to 8 mm (0.2 in to 0.3 in)

Procedure:

1. Switch off the inverter (see Section 5.3.1, page 42).
2. Turn the load-break switch of the AC disconnection unit **-Q63** on the inverter to the **OFF** position.
3. Pull the bracket out of the switch lever.
4. Hook a suitable padlock into the bracket and lock it. This will ensure that the switch lever cannot reconnect inadvertently.
5. Open the load-break switch of the circuit-breaker panel of the medium-voltage switchgear.
6. Close the grounding switch of the circuit breaker panel of the medium-voltage switchgear.
7. Attach magnetic signs indicating the name of the duly authorized person to the circuit breaker panel.

5.5 Reconnecting the MV Transformer

Connecting and disconnecting the AC voltage

Only a duly authorized person trained in electrical safety is allowed to connect and disconnect the AC voltage.

Procedure:

1. Remove the magnetic signs indicating the name of the duly authorized person from the circuit breaker panel.
2. Open the grounding switch at the circuit breaker panel of the medium-voltage switchgear.
3. Close the load-break switch on the circuit breaker panel of the medium-voltage switchgear.
4. Remove the padlock from the bracket of the load-break switch **-Q63**.
5. Turn the DC load-break switch **-Q63** to the **ON** position.
6. Restart the inverter (see Section 5.6.4, page 47).

5.6 Reconnecting the Inverter

5.6.1 Reconnecting the Supply Voltage and External Voltages

DANGER

Danger to life due to applied voltages

High voltages are present in the live components of the product. Touching live components results in death or serious injury due to electric shock.

- Before reconnecting, make sure that the panels are mounted (see Section 9.1.1, page 65).
- Before reconnecting, make sure that the protective covers are mounted (see Section 9.1.2, page 67).
- Before reconnecting, make sure that the hatches are closed (see Section 9.2, page 69).

Switching On the Supply Voltage

1. Remove the padlock from the bracket of the load-break switch **-Q62**.
2. Turn the DC load-break switch **-Q62** to the **ON** position.

Switching On the Auxiliary Energy Supply

1. Remove the padlock from the bracket of the load-break switch **-Q64**.
2. Turn the DC load-break switch **-Q64** to the **ON** position.

Switching On the Precharge Unit and the AC Circuit Breaker

1. Remove the padlock from the bracket of the load-break switch **-Q63**.
2. Turn the DC load-break switch **-Q63** to the **ON** position.

Switching on the Fans, Heating Elements, String Monitoring and DC Load-Break Switch

1. Remove the padlock from the bracket of the load-break switch **-Q61**.
2. Turn the DC load-break switch **-Q61** to the **ON** position.

5.6.2 Reconnecting the DC Side

5.6.3 Reconnecting the AC Side

⚠ DANGER

Danger to life due to applied voltages

High voltages are present in the live components of the product. Touching live components results in death or serious injury due to electric shock.

- Before reconnecting, make sure that the panels are mounted (see Section 9.1.1, page 65).
- Before reconnecting, make sure that the protective covers are mounted (see Section 9.1.2, page 67).
- Before reconnecting, make sure that the hatches are closed (see Section 9.2, page 69).

Procedure:

1. Make sure that the panels of the AC connection are mounted correctly.
2. Remove the padlock from the bracket of the load-break switch **-Q63**.
3. Turn the DC load-break switch **-Q63** to the **ON** position.

5.6.4 Restarting the Inverter

⚠ DANGER

Danger to life due to applied voltages

High voltages are present in the live components of the product. Touching live components results in death or serious injury due to electric shock.

- Before reconnecting, make sure that the panels are mounted (see Section 9.1.1, page 65).
- Before reconnecting, make sure that the protective covers are mounted (see Section 9.1.2, page 67).
- Before reconnecting, make sure that the hatches are closed (see Section 9.2, page 69).

Procedure:

- Turn the key switch **-S1** to **Start**.

6 Operation

6.1 Safety during Operation

NOTICE

Operation failure of the PV power plant due to incorrectly set parameters

If the parameter settings for grid management services are incorrect, the PV power plant may not be able to meet the requirements of the grid operator. This can involve yield losses and the inverter may have to be disconnected by the grid operator.

- When setting the modes of grid management services, ensure that the control procedures agreed with the grid operator are parameterized.
- If the inverter is operated with a Power Plant Controller, ensure that the mode for active power limitation and the mode for reactive power control are selected in the inverter via the Modbus protocol.

Ensuring accessibility of the inverter via Sunny Portal

During operation, the inverter transmits inverter data to Sunny Portal and if a disturbance occurs, it generates a message which is sent to the configured e-mail address. If Sunny Portal cannot be accessed from the inverter, only limited monitoring of the PV system will be possible.

- Ensure that the inverter can be accessed via the IP address.
- Ensure that proxy use in the parameters is configured in accordance with the specifications of the system network.
- Ensure that the parameters for communication between the inverter and Sunny Portal are correctly configured.
- Ensure that a connection test to Sunny Portal is performed successfully.

6.2 Localization of the User Interface

You have the option of localizing the user interface so that it differs from the country settings. You can localize the date format, time format, decimal and thousand separators and the first day of the week.

The localization settings will be active until the next change.

The localization settings can be changed at login and will be active until the next logout.

Procedure:

1. In the status info line, select German and select the option **Localization**.
   Select [**Localize**] in the drop-down menu.
2. Adjust the desired localizations.
3. Select **[OK]**.
   Select [**Log in**].

6.3 Selecting the Language

You have the option of setting the language of the user interface so that it differs from the country settings. The setting always applies locally.

The localization settings will be active until the next change.

The localization settings can be changed at login and will be active until the next logout.

Procedure:

1. Log into the user interface (see Section 9.3, page 70).
2. In the status info line select German and select the desired language from the drop-down list.

6.4 Setting the System Time

1. Log into the user interface as an installer (see Section 9.3, page 70).
2. Select the area with date and time in the status info line.
3. Enter the current time.
4. Select [**Save**] to save the time change.

6.5 Setting the Brightness on the Touch Display

1. Select ☀ in the status info line.
2. Adjust brightness via the arrow keys on a scale of ten. The selected brightness is shown on a test screen.
3. Select [**Save**] to save the change to the brightness setting.

6.6 Changing the Password for the User Groups

To change the password for the "installer" user group, you must be logged in as an installer.

The password of the user group "User" can only be changed by the user group "Installer".

To change the password for the user group "User", you can be logged in as a user or an installer.

Procedure:

1. Log into the user interface (see Section 9.3, page 70).
2. Select the role of the user group for which the password is to be changed.
3. Enter the new password:
4. To confirm, enter the new password again.
5. Select [**Save**].

6.7 Display of Measured Values

6.7.1 Displaying Measured Values in the Components View

On the Analysis pages [**DC side**], [**Inverters**], [**AC side**] and [**Utility grid**], you can have the corresponding instantaneous values displayed in a diagram. It is possible to have data with two different units displayed on two Y axes.

Depending on the selected time period, you can select different measured values for display.

Procedure:

1. Log into the user interface (see Section 9.3, page 70).
2. In the main navigation select .
3. Select the page with the desired component.
4. Select the desired time period for the display in the lower part of the content area. For reasons of better comparison, all months are displayed with 31 days.
   Useful hint: You can also change the display time period after selection of the instantaneous values for display.
5. Select [**Select data**].
   - To select instantaneous values for one of the two Y axes, select the instantaneous values in the appropriate column of the drop-down box.
     Useful hint: If the same unit is assigned to both axes, all instantaneous values with another unit are grayed out.
   - To adopt the selection, select [**Load**].

   Select the instantaneous values to be displayed from the instantaneous values below the diagram. Data with the same units are automatically assigned to one Y axis and the horizontal gridlines are adjusted to fit the data.
6. Select the instantaneous values to be displayed from the list which now appears. The instantaneous values can be assigned to the left or right Y axis.
7. To delete data from the display, select the instantaneous value again. The corresponding curve will be removed from the diagram.
8. To display data with other units, select the data on the left or right Y axis again. The curves will be deleted from the diagram and you can select other data.

6.7.2 Displaying Measured Values in the Detail Analysis

On the page **Detail analysis**, instantaneous value can be displayed in a diagram. It is possible to have data with two different units displayed on two Y axes.

Depending on the selected time period, you can select different measured values for display.

Procedure:

1. Log into the user interface (see Section 9.3, page 70).
2. In the main navigation select .
3. Select the page [**Detail analysis**].
4. Select the desired time period for the display in the upper part of the content area. For reasons of better comparison, all months are displayed with 31 days.
   Useful hint: You can also change the display time period after selection of the instantaneous values for display.
5. To select the instantaneous values for the diagram, select [**Select instantaneous values for left Y axis**].
6. To select the instantaneous values for the left Y axis, select the corresponding instantaneous values in the left column of the drop-down box.

   To select the instantaneous values for the right Y axis, select the corresponding instantaneous values in the right column of the drop-down box.
   Useful hint: If the same unit is assigned to both axes, all instantaneous values with another unit are grayed out.
7. Select [**OK**] to create the diagram.
8. To delete data from the display, select the instantaneous value in the legend. The corresponding curve will be removed from the diagram.
9. To display data with other units, select [**Select instantaneous values for left Y axis**] again and select the data of the Y axis again. The curves will be deleted from the diagram and you can select other data.

6.8 Search Function

6.8.1 Search based on the ID Number

Parameters, instantaneous values and the pages of the user interface have unique ID numbers. By means of these numbers, parameters, instantaneous values or pages can be found quickly.

Procedure:

1. Log into the user interface (see Section 9.3, page 70).
2. Enter the required ID number of the page, parameter or instantaneous value in the status info line in the field **#XXXX**.

6.8.2 Targeted Search

It is possible to narrow the search down to obtain faster results when searching for parameters and instantaneous values. The search will be carried out in the favorites, in the Top 50 and in all parameters and instantaneous values.

Procedure:

1. Call up the parameter overview (see Section 9.4, page 71).

   or

   Call up the overview of instantaneous values (see Section 9.5, page 71).
2. In the field **Search parameter** or **Search instantaneous value**, enter the first signs of the parameter or instantaneous value. You can search for long names, short names or numbers.

☑ As you make your entry in the search field, the list of parameters or instantaneous values will be reduced to the matching entries.

☑ In the tabs of the subnavigations, the number of filtered parameters and instantaneous values is displayed.

6.9 Creating Favorites

Parameters and instantaneous values can be marked as favorites. The marked parameters and instantaneous values are displayed in a separate list. You can create a list with the most important parameters and instantaneous values.

The favorites are created separately for the individual user groups and saved separately for access via touch display on the device itself or via Internet.

The favorites are saved to the device.

The favorites are saved to the computer. Thus, the favorites of a particular inverter are automatically adopted when you log in to another system.

An exchange of favorite lists between the individual user groups, the inverter and the computer is possible via export and import.

Procedure:

1. Call up the overview for parameters or instantaneous values (see Section 9, page 65).
2. Select the parameter or instantaneous value and select the favorite identifier ★ in the entry field.
3. In the line of the parameter or instantaneous value, select the favorite identifier ★.

6.10 Using Parameters to Activate and Deactivate the Inverter Standby

1. Call up the parameter overview (see Section 9.4, page 71).
2. To set the inverter to operating state "Standby", set the parameter **RemRdy** to **DISABLED**.
3. To restart the inverter, set the parameter **RemRdy** to **ENABLED**.

6.11 Importing Files

For importing files, you have the following options: transfer via an FTP program, reading from a medium (SD memory card, USB flash drive) connected to the communication interface, or reading from a file in the local directory of the computer used.

The files to be imported must be uploaded to the internal cache. In the second step, the import file can be imported from the internal cache to the given application. This enables several files to be uploaded to the cache before performing the second step.

The uploaded files can be deleted from the internal cache after importing.

Procedure:

1. Log into the user interface as an installer (see Section 9.3, page 70).
2. Select in the main navigation and select **Import** from the drop-down list.
3. Select the required data type for import from the list.
4. To import a file to the cache, select [**Copy file from external device**].
5. If the file can be imported from a connected medium, select the desired file from the list. The file source is indicated in the first column of the list.
6. If the file is to be read from a local directory of the computer used, select [**Browse...**] and then select the desired file in the directory.

   In order to upload the file to the internal cache, select the desired file from the list.
7. To execute the file in the appropriate application, select the desired file from the list.

6.12 Exporting Files

For better management of data and settings, you have the following options for exporting different types of information: transfer via an FTP program, export to an external storage medium (SD memory card, USB flash drive) or export to a file in the local directory of a computer. To do this, a storage medium must be connected to the communication interface or the computer must be connected to the inverter.

First, the files to be exported must be generated and uploaded to the internal cache. In the second step, the export file can be exported from the internal cache to the corresponding storage location. This enables several files of the same data type to be exported from the cache at the same time.

After exporting, you can delete the exported files from the internal cache.

Procedure:

1. Log into the user interface as an installer (see Section 9.3, page 70).
2. In the main navigation, select and select **Export** from the drop-down list.
3. Select the desired data type for export from the list.
4. In order to generate a file for export, select [**Generate new parameter file**].
5. If you want to export parameters and settings, select the desired export mode:
   - **Cloning**: All parameters and settings are exported with the IP address of the inverter.
   - **All**: The parameters and settings are exported without the IP address of the inverter.
   - **Selection**: The specific parameters to be exported can be selected from a list.
6. Select the file to be exported from the list.
7. Select the target location for the export:
   - **Delete file**: The selected file will be deleted from the cache.
   - **Copy file to external device**: The file will be saved to an external storage medium.

- **Download**: The file will be downloaded to the computer used.

8. Complete the file export with [**OK**].

6.13 Adjusting Network Ports

If you want the inverter to be accessible via the Internet so that, for instance, you have direct access from Sunny Portal, you may have to configure port forwarding in your router. This may require adjustment of the network ports.

i Adjusting the network ports

Check your access to the user interface before you change the setting **Public virtual HTTP port** on the user interface. In most cases, the settings do not have to be changed manually, as the router automatically forwards the queries to the correct ports via the network. Before adjusting the ports, contact your network administrator.

i Unauthorized access to the inverter

If you activate the Modbus protocol, unauthorized access to the inverter will be possible. In this case, users without a password will be able to view the instantaneous values of supported devices or even change parameters. Using a VPN is recommended.

Procedure:

1. Call up the parameter overview (see Section 9.4, page 71).
2. In the parameter **Netw.StdGw.IpAdr**, enter the IP address of the standard gateway via which the inverter can be accessed.
3. Enter the IP address of the DNS server in the parameter **Netw.Dns.SrvIpAdr**.
4. If you want to use the proxy server for Sunny Portal, activate the parameter **Netw.Proxy.SunnyPortalEna**.
5. If you want to use a proxy authentication, activate the parameter **Netw.Proxy.AuthEna**.
6. Enter the port of the proxy server in the parameter **Netw.Proxy.Port**. The default setting is **8080**.
7. If you would like to use the Modbus protocol, activate the box **Use Modbus**.
8. Enter the address of the proxy server in the parameter **Netw.Proxy.Adr**.
9. Enter the user names and password of your proxy server in the parameters **Netw.Proxy.Usr** and **Netw.Proxy.Pwd**.

6.14 Registering the Inverter in Sunny Portal

Requirement:

☐ There must be a user created in Sunny Portal.

☐ The system network must be configured.

Procedure:

1. Call up the parameter overview (see Section 9.4, page 71).
2. Enter the name of the system in the parameter **PortalId.Plnt.Nam**.
3. Enter the ID number of the system in the parameter **PortalId.Plnt.ID**.
4. Select the connection type in the parameter **PortalId.UpId.Mod**.
5. To change the e-mail address to which messages are to be sent, enter the desired address in the parameter **PartalId.Usr.Mail**.
6. To register the system in Sunny Portal, select the button [**Execute action**] in the parameter **PortalId.Act.Rgst.Plnt**.
7. To register the inverter in Sunny Portal, select the button [**Execute action**] in the parameter **PortalId.Act.Rgst.Dev**.
8. To test the connection from the inverter to Sunny Portal, select the button [**Execute action**] in the parameter **PortalId.Act.Conn.Chk**.

9. Call up the overview of instantaneous values (see Section 9.5, page 71).
10. In the instantaneous value **PortalId.Act.Conn.Chk.Rsl**, check whether the connection has been successfully established.
    - ☑ **Ok** is displayed in the instantaneous value. Connection has been established successfully.
    - ✖ **Ok** is not displayed in the instantaneous value?

      The connection to Sunny Portal has not been established.
      - Ensure that all settings for Sunny Portal in the parameters and the proxy server settings comply with the system configuration.
      - Ensure that the inverter can be accessed via the IP address.
      - Contact SMA Service Line.
11. Select the data upload frequency in the parameter **PortalId.Upld.Cyc**.
12. To complete the registration process, register the new devices in Sunny Portal.

7 Troubleshooting

7.1 Safety during Troubleshooting

⚠ DANGER

Danger to life from electric shock due to high voltages on the product

High voltages can be present on the product under fault conditions. Touching live components results in death or serious injury due to electric shock.

- Observe all safety information when working on the product.
- Wear suitable personal protective equipment for all work on the product.
- If you cannot remedy the disturbance with the help of this document, contact the Service (see Section 13 "Contact", page 111).

7.2 Activating Alert in the Event of a Fault

You can be notified by e-mail of events that have occurred. This allows a rapid response to failures in the PV power plant and minimizes downtimes. The alert is deactivated upon delivery.

Procedure:

1. Call up the parameter overview (see Section 9.4, page 71).
2. To activate the alarm via e-mail, set the parameter **Alrm.Mail.Ena** to **On**.
3. Enter the address or IP address of the relevant SMTP server in the parameter **Alrm.Smtp.Adr**.
4. Enter the port of the relevant SMTP server in the parameter **Alrm.Smtp.Port**.
5. Enter the user name for the SMTP authentication in the parameter **Alrm.Smtp.Usr**.
6. Enter the password for the SMTP authentication in the parameter **Alrm.Smtp.Pwd**.
7. Enter the required encryption in the parameter **Alrm.Smtp.Cry**.
8. Enter the e-mail address to which e-mails are to be sent in the parameter **Alrm.Smtp.Recp**.
9. If you do not wish the sender of the e-mail to contain the address of the SMTP server, enter the desired address in the parameter **Alrm.Smtp.TxAdr**.
10. To create a test e-mail, select the parameter **Alrm.Smtp.Tst** and click the button [**test**].
    - ☑ A test e-mail will be sent to the specified e-mail address.
    - ✖ No test e-mail received?
      - Check whether the test e-mail is in the spam folder.
      - Make sure that the network settings of the communication unit are correct.
      - Ensure that the settings of the SMTP server are correct.

7.3 Displaying Disturbance Messages

In the event overview, disturbance messages are displayed detailing the events that have occurred.

Procedure:

1. To display all disturbance messages, call up the event overview (see Section 9.6, page 71). All events will be displayed in chronological order.
2. To find warnings and error messages faster, select Typ. This will filter the events.

7.4 Acknowledging Disturbance Messages

7.4.1 Acknowledging Disturbance Messages via the User Interface

Dealing with disturbances

Disturbance messages should only be acknowledged once the underlying causes have been eliminated.

If the causes of the disturbance have not been eliminated, the disturbance will still be detected after acknowledgment and the disturbance message will reappear.

Procedure:

1. Call up the parameter overview (see Section 9.4, page 71).
2. To acknowledge all current errors, set the parameter **ErrClr** to **True** for each error, one after the other.
3. To acknowledge any further error, set the parameter **ErrClr** to **True** again.
4. Adopt changes of the parameter with [**Save**].

7.4.2 Acknowledging Disturbance Messages via the Start/Stop Key Switch -S1

Dealing with disturbances

Disturbance messages should only be acknowledged once the underlying causes have been eliminated.

If the causes of the disturbance have not been eliminated, the disturbance will still be detected after acknowledgment and the disturbance message will reappear.

Procedure:

- Turn the Start/Stop key switch **-S1** to **Stop** and then back to **Start** after five seconds.

7.5 Remedial Action in Case of Disturbances

7.5.1 Troubleshooting for non-feeding of the inverter

It can occur under certain circumstances that the inverter does not feed into the utility grid. The **OpStt** instantaneous value displays the current operating state of the inverter (see Section 10.1, page 72).

Only when all error causes have been corrected can the inverter change back over to feed-in operation.

Operating state	Possible causes and remedies
Stop	• View the cause for the "Stop" operating state in the **StopReas** instantaneous value: **No Stop Reason**: There is no reason for the "Stop" operating state. **Key Switch**: The inverter was switched to the "Stop" operating state with the **-S1** start/stop key switch. **Parameter InvOpMod**: The inverter was put into the "Stop" operating state via the **InvOpMod** parameter. **Stop External X440:3**: The inverter was put into the "Stop" operating state via the external fast stop function. **SCADA or PPC, Modbus**: The inverter was put into the "Stop" operating state via the Modbus protocol.

Operating state	Possible causes and remedies
WaitAC	• Check the amplitude of the AC voltage. • Check the frequency of the AC voltage. • Check the phase of the AC voltage. • The entered grid limits in the **VCtl.xxx** or **HzCtl. xxx** parameters were violated and the inverter has disconnected from the utility grid. Check the waiting time for the grid reconnection in the **WaitGriTm** instantaneous value.
WaitDC	• Check the DC voltage.
Standby	• View the cause for the "Standby" operating state in the **StandbyReas** instantaneous value: **No Standby Reason**: There is no reason for the "Standby" operating state. **SCADA or PPC, Modbus**: The inverter was put into the "Standby" operating state via the Modbus protocol. **Low PV Power or Grid Synchronization**: The created PV power is below the connection power of the inverter or the grid synchronization was not successful. **Power Monitoring Modul**: The inverter was put into the "Standby" operating state due to missing default values for the power regulation and the corresponding configuration in the **GriMng.ComFltFlbVArMod** and **GriMng.ComFltFlbWMod** parameters (see Section 10.3.4, page 89). **Parameter RemRdy**: The inverter was put into the "Standby" operating state via the **RemRdy** in den parameter. **Stop External X440:7**: The inverter was put into the "Standby" operating state via the external standby function.
Error	• View the cause of the error in the **ErrNo** instantaneous value.

7.5.2 Inverter Behavior in Case of Disturbances

If a disturbance occurs during operation, this may be caused by a warning or an error. In case of an error, inverter operation will be interrupted.

There are two levels assigned to each disturbance which influence the display and system behavior. Only in the case of certain disturbances will the inverter behavior differ depending on the level. The level is increased from 1 to 2 if the disturbance occurs five times within two hours or without interruption for two hours.

If a disturbance occurs, an "incoming" disturbance entry is generated in the event overview. This entry includes the device in which the disturbance was detected, a warning symbol, the exact location of the error source within the assembly, an error number, a description of the disturbance and the time when the disturbance occurred.

The cause of the disturbance must be determined and remedied before you acknowledge the disturbance.

Once the disturbance has been acknowledged, the inverter checks whether the cause of the disturbance is eliminated. If the cause of the disturbance still exists after the disturbance has been acknowledged, the inverter remains in the operating state "Disturbance". If the disturbance is no longer present, the disturbance is entered in the event list as "outgoing".

Inverter behavior in the disturbance levels 1 and 2:

- **Waiting time**

  In case of an error, the inverter switches to the operating state "Disturbance" and opens the AC disconnection unit and DC switchgear. The inverter does not feed into the grid for the defined waiting time.

  The waiting time specifies how long the inverter will be prevented from feeding into the utility grid. Once the waiting time has elapsed, the inverter checks whether the cause of the disturbance has been remedied.

  If the cause of the disturbance still exists after the waiting time has expired or the disturbance has been acknowledged, the inverter remains in the operating state "Disturbance".

- **Waiting for acknowledgement**

  The inverter switches to the operating state "Disturbance" and opens the AC disconnection unit and DC switchgear. The inverter does not feed in until the disturbance is acknowledged.

- **Day change**

  The inverter switches to the operating state "Disturbance" and opens the AC disconnection unit and DC switchgear. The inverter does not feed in.

  The disturbance is automatically reset after a day change, or it can be acknowledged once the cause has been eliminated.

- **Warning**

  A warning does not affect inverter behavior.

Once the cause of the disturbance has been rectified and the disturbance is no longer displayed, it is deleted from the fault memory. To view previous disturbances after they have been acknowledged on the user interface, an event report is saved on the SD memory card. The event report logs the time and type of disturbance. The event report can also be displayed on the user interface.

Depending on the type of disturbance, a reset may be performed. When this happens, the relays are checked and the supply voltage of the control system is switched off. This process takes less than one minute. While the control system is booting, the regular waiting times for grid monitoring are complied with.

7.5.3 Explanation of the Error Tables

You will find the following information in the error tables in the following sections:

		A		B	
Error no.	**Explanation**	**S1**	**S2**	**R**	**Corrective measures**
9009	Fast stop tripped manually	5 min	Q	–	• Release switch again once danger is eliminated.

Figure 16: Explanation of the error table (example)

Position	Explanation
A	Behavior of the inverter: disturbance level S1, disturbance level S2 • s / min: waiting time • D: day change • Q: waiting for acknowledgement • W: warning
B	Reset

7.5.4 Error Numbers 01xx to 13xx - Disturbance on the Utility Grid

After a grid failure, the inverter monitors the utility grid for a specific period before reconnecting.

When the inverter monitors the utility grid after a grid error, the grid monitoring time is complied with.

Certain errors, such as grid errors, cause the inverter to shut down. In this case, the instantaneous value **WaitGriTm** indicates the time for which the inverter monitors the utility grid before reconnecting. This grid monitoring time can be defined in parameter **GdErrTm**.

Error no.	Explanation	Inverter behavior			Corrective measures
		S1	S2	R	
0104	Grid voltage is too high. Overvoltage detected by standard monitoring.	30 s	30 s	–	• Check the grid voltage. • Check grid connections. • Check stability of the utility grid. • Make sure the external fuses work properly. • Make sure the AC cable connections are tight. • Check the configured grid limits.
0204	Grid voltage is too low. Undervoltage detected by standard monitoring.	30 s	30 s	–	
0205	One line conductor of the utility grid has failed.	30 s	30 s	–	
0502	Power frequency is too low. Power frequency disturbance detected by standard monitoring.	30 s	30 s	–	• Check power frequency. • Check the display of the grid monitoring relay. • Make sure the fuses in the load circuit function properly. • Check the configured grid limits.
0503	Power frequency is too high. Power frequency disturbance detected by standard monitoring.	30 s	30 s	–	

7.5.5 Error Numbers 34xx to 40xx - Disturbance on the PV Array

Error no.	Explanation	Inverter behavior			Corrective measures
		S1	S2	R	
3501	The insulation monitoring device has measured a too low grounding resistance.	30 min	30 min	–	• Check the PV array for ground faults.
3502	The GFDI has tripped.	30 min	30 min	–	
3519	Light repeater of the insulation monitoring is defective.	30 s	1 min		

Error no.	Explanation	Inverter behavior			Corrective measures
		S1	S2	R	
3601	Leakage current to ground has occurred in the PV array or the threshold defined in parameter **PvGnd.RisIsoErrLim** has been reached.	W	W	–	• Check the grounding and equipotential bonding. • Check the module wiring and system design. • Check parameter **PvGnd.RisIsoErrLim**.
4003	Reverse currents detected in the PV array or DC connection polarity reversed.	Q	Q	–	• Check the PV modules for short circuits. • Check the module wiring and system design. • Check the DC terminals for correct polarity. • Check the functionality of the entire string.

7.5.6 Error Numbers 6xx to 9xx - Disturbance on the Inverter

Error no.	Explanation	Inverter behavior			Corrective measures
		S1	S2	R	
6013	Calibration data of DC measurement cannot be loaded.	1 min	30 min	–	• Contact SMA Service Line.
6014	Calibration data of DC voltage measurement cannot be loaded.	1 min	30 min	–	• Contact SMA Service Line.
6119	Disturbance in internal communication of the processor assembly	15 min	5 min	–	• Contact SMA Service Line.
6120	Watchdog has tripped.	1 min	1 min	x	• Contact SMA Service Line.
6318	Missing internal connection of an assembly	30 s	1 min	–	• Contact SMA Service Line.
6319	Incorrect internal connection of an assembly	30 s	1 min	–	• Contact SMA Service Line.
6405	Overvoltage in the DC link of the inverter bridge	30 s	5 min	x in S2	• Contact SMA Service Line.
6422	Inverter bridge in undefined state	30 s	5 min	–	• Contact SMA Service Line.
6423	Error: temperature of MV transformer is too high. Disconnection limit exceeded. Inverter stops feed-in operation.	30 s	30 s	–	• Check the MV transformer.
6440	Hermetic protection (oil level) of the MV transformer no longer assured.	30 s	5 min	–	• Check the MV transformer.

Error no.	Explanation	Inverter behavior			Corrective measures
		S1	S2	R	
6456	Pre-charging circuit of DC link is defective.	5 min	5 min	–	• Contact SMA Service Line.
6479	Data of coding plug is inconsistent.	Q	Q	–	• Contact SMA Service Line.
6480	Coding plug is not plugged in or not readable.	Q	Q	–	• Contact SMA Service Line.
6481	Coding plug is defective.	Q	Q	–	• Contact SMA Service Line.
6482	Storage area in coding plug is defective.	Q	Q	–	• Contact SMA Service Line.
6484	Invalid firmware version found.	Q	Q	–	• Contact SMA Service Line.
6485	Hermetic protection (gas fill level) of the MV transformer is no longer assured.	5 min	5 min		• Check the MV transformer.
6502	Temperature of inverter bridge is too high.	30 s	30 s	–	• Check function of the fans. • Clean the fans. • Clean clogged fan inlets and ventilation plates.
6506	Warning: temperature of the MV transformer is too high.	30 s	30 s	–	• Check the MV transformer.
6508	Outside temperature is too high.	30 s	30 s 1 min	–	–
6512	Outside temperature is too low.	30 s	30 s 1 min	–	–
6515	Temperature inside the inverter is too high.	30 s	30 s 1 min	–	–
6516	Warning: temperature at the sine-wave filter choke is too high.	5 min	Q 1 min	–	–
6517	Error: temperature at the sine-wave filter choke is too high. Disconnection limit exceeded. Inverter stops feed-in operation.	30 s	1 min	–	• Contact SMA Service Line.
6605	An internal fast stop has tripped.				• Contact SMA Service Line.
7002	Cable break or short circuit at inverter temperature sensor	30 s	30 s	–	• Check the wiring of the temperature sensor. • Contact SMA Service Line.
7004		30 s	30 s	–	
7005		30 s	30 s	–	
7016		30 s	30 s	–	

Error no.	Explanation	Inverter behavior			Corrective measures
		S1	S2	R	
7501	Interior fan is defective.	30 s	30 s	–	• Check function of the fans. • Clean the fans. • Contact SMA Service Line.
7502		30 s	30 s	–	
7503	Inverter bridge fan is defective.	30 s	30 s	–	
7512	Cable break or short circuit at internal fan	30 s	30 s	–	• Contact SMA Service Line.
7513	Filter of internal fan is soiled.	30 s	30 s	–	• Check function of the fans. • Clean the fans.
7600	Internal communication error has occurred.	30 s	15 min	–	• Contact SMA Service Line.
7601	Internal inverter error	30 s	30 s	–	• Contact SMA Service Line.
7602	Internal communication error has occurred or communication is interrupted.	30 s	30 s	–	• Contact SMA Service Line.
7620		30 s	180 min	–	• Contact SMA Service Line.
7621		30 s	15 min	–	• Contact SMA Service Line.
7708	Faulty switching status of Remote GFDI	5 min	15 min	–	• Contact SMA Service Line.
7801	The surge arrester is defective or the back-up fuse of the surge arrester has tripped.	W	W	–	• Check the surge arrester. • Check the back-up fuse of the surge arrester.
7901	Reverse current has occurred in PV array.	1 min	D	x in S2	• Contact SMA Service Line.
8712	Warning: failure of active power specifications transmitted via communication. The last valid value or, after a day change, **Pmax** is used. Once valid setpoints are available again, these will be used.	1 min	1 min	–	• Contact SMA Service Line.
8713	Error: failure of active power specifications transmitted via communication. Inverter stops feed-in operation.	1 min	1 min	–	• Contact SMA Service Line.
9009	Fast stop tripped by processor assembly.	5 min	Q	–	• Eliminate error and switch fast stop back on.
9023	Fast stop tripped by DC overcurrent.	5 min	Q	–	• Eliminate error and switch fast stop back on.

Error no.	Explanation	Inverter behavior			Corrective measures
		S1	S2	R	
9024	Fast stop tripped by GFDI/Remote GFDI.	5 min	Q	–	• Check the fast stop cabling. • Eliminate error and switch fast stop back on.
9025	Fast stop manually tripped at key switch **-S2**.	5 min	Q	–	• Eliminate error and switch fast stop back on.
9026	Fast stop tripped by the external fast stop.	5 min	Q	–	• Eliminate error and switch fast stop back on.
9027	Fast stop tripped by AC overcurrent.	5 min	Q	–	• Eliminate error and switch fast stop back on.
9029	Fast stop has tripped.	5 min	Q	–	• Eliminate error and switch fast stop back on.
9030	Fast stop tripped by redundant monitoring of the processor assembly.	5 min	Q	–	• Eliminate error and switch fast stop back on.

8 Disposal

Proper disassembly and disposal

When the inverter has reached the end of its service life, it becomes electronic waste. Electronic waste contains on the one hand valuable materials which can be recycled as secondary raw materials, and on the other, substances which are hazardous to the environment. Contact your local commercial disposal services for information on optimum material utilization.

- Prior to disassembly, perform a visual inspection to ensure that the supporting elements of the inverter are not rusted or unstable.

9 Periodic Actions

9.1 Mounting and Disassembly Work

9.1.1 Disassembling and Mounting the Panels

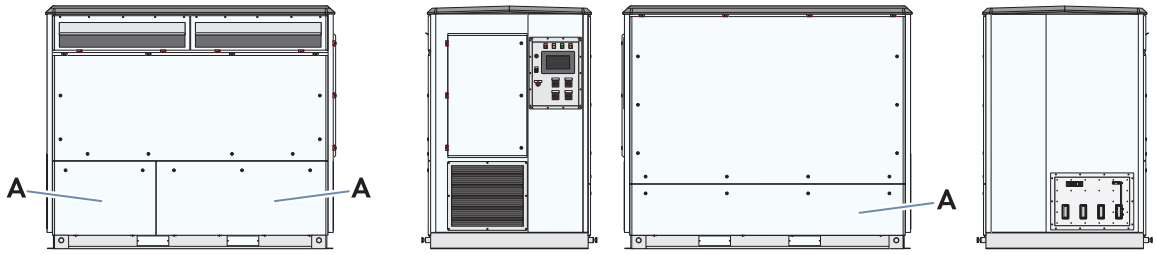


Figure 17: Overview of the panels

Position	Designation
A	Panel

⚠ DANGER

Danger to life due to applied voltages

High voltages are present in the live components of the product. Touching live components results in death or serious injury due to electric shock.

- Always disconnect the inverter from the power transmission path and from the control path if no voltage is required for working on the product (see Section 5.3, page 42).
- After switching off the inverter, wait at least 15 minutes before opening it to allow the capacitors to discharge completely (see Section 5.3, page 42).
- Wear suitable personal protective equipment of the corresponding hazard risk category for all work when the power transmission path is connected. The hazard risk category of the various areas of the inverter are different. The areas are identified with warning labels.
- Wear suitable personal protective equipment for all work when the control path is connected.
- Always perform all work on the product in compliance with the regulations specified in 29 CFR, Chapter XVII, Part 1910 (OSHA), NEC, and NFPA 70E.
- Do not touch any live components.
- Observe all warning messages on the product and in the documentation.
- Observe all safety information of the module manufacturer.
- The product must not be operated with open covers or doors.

⚠ WARNING

Danger to life due to electric arc if there are tools inside the product

When reconnecting or during operation, an electric arc can occur if there are tools in the product creating a conductive connection between the live components. This can result in death or serious injury.

- Before commissioning or reconnection, verify that no tools are inside the product.

⚠ CAUTION

Danger of crushing and collision when carelessly working on the product

Carelessly working on the product could result in crushing injuries or collisions with edges.

- Wear personal protective equipment for all work on the product.

⚠ CAUTION

Risk of injury when using unsuitable tools

Using unsuitable tools can result in injuries.

- Ensure that the tools are suitable for the work to be carried out.
- Wear personal protective equipment for all work on the product.

NOTICE

Property damage due to rupture of grounding conductors

The components are connected to the inverter via the grounding conductor. If the roof is not disassembled correctly, the grounding conductors may be pulled out.

- Take care not to damage the grounding conductors during disassembly.

Disassembling the panels

1. Open the locks with a square key wrench.
2. Detach the grounding straps from the panels.
3. Slightly raise and remove the panels.

Mounting the panels

Requirement:

☐ The protective covers in the connection area must be mounted.

Procedure:

1. Attach the grounding straps to the panels (torque: 8 Nm to 10 Nm (70.8 in-lb to 88.5 in-lb)).
2. Ensure that the grounding straps are firmly in place.
3. Mount the panels.
4. Close the locks with a square key wrench.

9.1.2 Disassembling and Mounting the Protective Covers on the Inverter

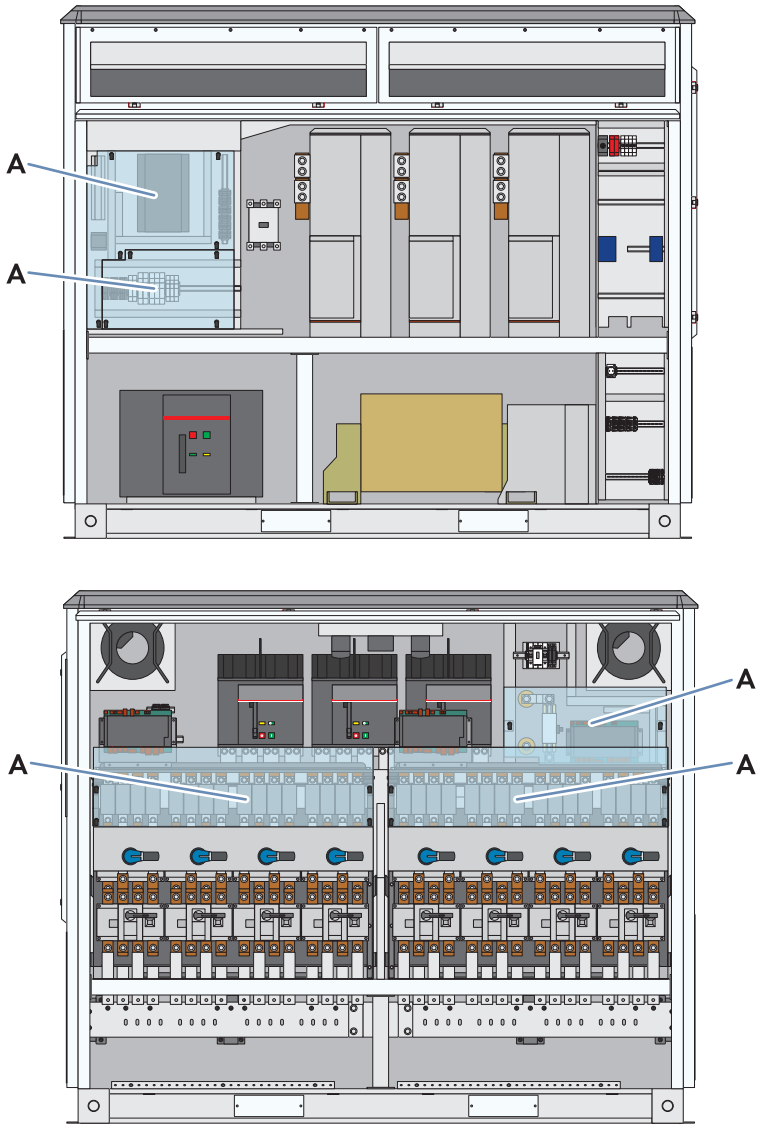


Figure 18: Position of the protective covers

Position	Designation
A	Protective cover

⚠ DANGER

Danger to life due to applied voltages

High voltages are present in the live components of the product. Touching live components results in death or serious injury due to electric shock.

- Always disconnect the inverter from the power transmission path and from the control path if no voltage is required for working on the product (see Section 5.3, page 42).
- After switching off the inverter, wait at least 15 minutes before opening it to allow the capacitors to discharge completely (see Section 5.3, page 42).
- Wear suitable personal protective equipment of the corresponding hazard risk category for all work when the power transmission path is connected. The hazard risk category of the various areas of the inverter are different. The areas are identified with warning labels.
- Wear suitable personal protective equipment for all work when the control path is connected.
- Always perform all work on the product in compliance with the regulations specified in 29 CFR, Chapter XVII, Part 1910 (OSHA), NEC, and NFPA 70E.
- Do not touch any live components.
- Observe all warning messages on the product and in the documentation.
- Observe all safety information of the module manufacturer.
- The product must not be operated with open covers or doors.

⚠ WARNING

Danger to life due to electric arc if there are tools inside the product

When reconnecting or during operation, an electric arc can occur if there are tools in the product creating a conductive connection between the live components. This can result in death or serious injury.

- Before commissioning or reconnection, verify that no tools are inside the product.

⚠ CAUTION

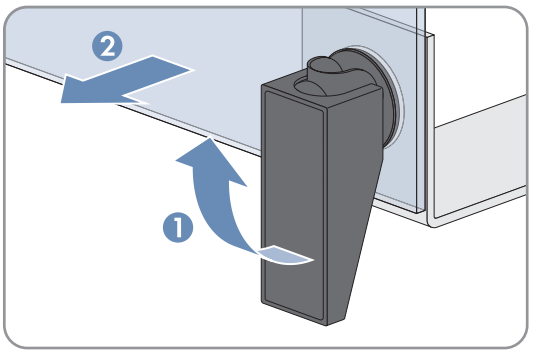
Danger of crushing and collision when carelessly working on the product

Carelessly working on the product could result in crushing injuries or collisions with edges.

- Wear personal protective equipment for all work on the product.

Disassembling the protective covers

1. Ensure that no voltage is present.
2. Open the clamping brackets.



3. Remove the protective cover forwards. The clamping brackets remain in the protective cover.

Mounting the protective covers

1. Mount the protective cover to the bracket. The clamping brackets must be located over the holes in the bracket.
2. Close the clamping brackets.

9.2 Opening and Closing the Hatches

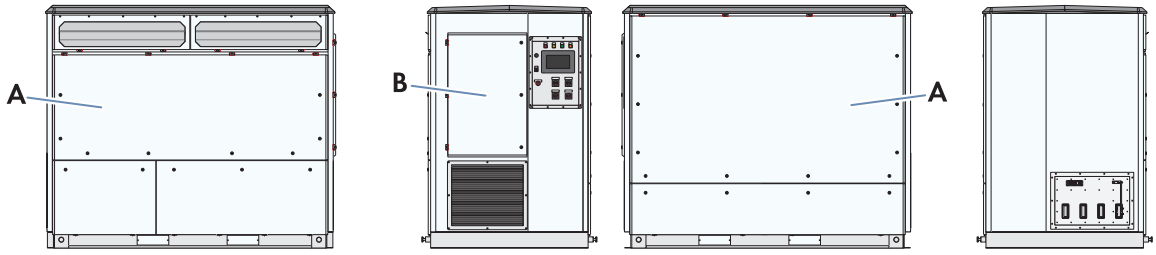


Figure 19: Overview of the hatches

Position	Designation
A	Hatch with gas springs
B	Door

⚠ DANGER

Danger to life due to applied voltages

High voltages are present in the live components of the product. Touching live components results in death or serious injury due to electric shock.

- Always disconnect the inverter from the power transmission path and from the control path if no voltage is required for working on the product (see Section 5.3, page 42).
- After switching off the inverter, wait at least 15 minutes before opening it to allow the capacitors to discharge completely (see Section 5.3, page 42).
- Wear suitable personal protective equipment of the corresponding hazard risk category for all work when the power transmission path is connected. The hazard risk category of the various areas of the inverter are different. The areas are identified with warning labels.
- Wear suitable personal protective equipment for all work when the control path is connected.
- Always perform all work on the product in compliance with the regulations specified in 29 CFR, Chapter XVII, Part 1910 (OSHA), NEC, and NFPA 70E.
- Do not touch any live components.
- Observe all warning messages on the product and in the documentation.
- Observe all safety information of the module manufacturer.
- The product must not be operated with open covers or doors.

⚠ WARNING

Danger to life due to electric arc if there are tools inside the product

When reconnecting or during operation, an electric arc can occur if there are tools in the product creating a conductive connection between the live components. This can result in death or serious injury.

- Before commissioning or reconnection, verify that no tools are inside the product.

⚠ CAUTION

Danger of crushing and collision when carelessly working on the product

Carelessly working on the product could result in crushing injuries or collisions with edges.

- Wear personal protective equipment for all work on the product.

⚠ CAUTION

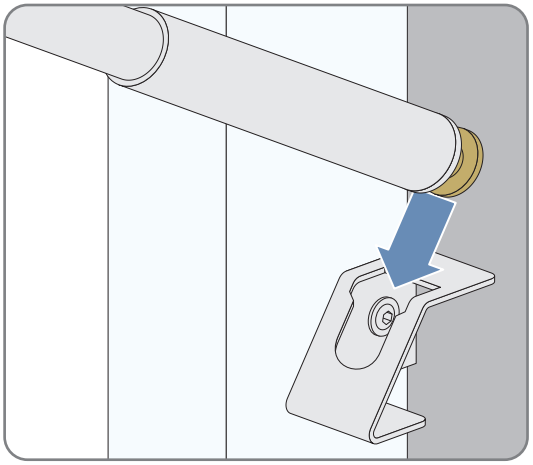
Risk of injury when using unsuitable tools

Using unsuitable tools can result in injuries.

- Ensure that the tools are suitable for the work to be carried out.
- Wear personal protective equipment for all work on the product.

Opening hatches

1. Open the hatch locks with a square key wrench. Push gently against the hatch and note that the hatches are automatically pushed upwards by the gas springs.
2. To secure the hatch, fold down the safety rod from the hatch and secure it in the holder.



3. Open the door locks with a square key wrench. Lightly press against the door.

Closing hatches

Requirement:

☐ Protective covers must be mounted (see Section 9.1.2, page 67).

Procedure:

1. Remove the safety rod from the holder and secure it in the spring holders in the hatch.
2. Press the hatch down.
3. Close the locks of the hatches and the door with a square key wrench. Lightly press against the hatch or door.

9.3 Logging Into the User Interface

Prior to performing any work, you must log into the user interface with your given user role. The following roles are available: user, installer, service partner and SMA Service.

If you are logged in as installer, you can change to the role of user at any time without entering a password. The next time you log in as installer, you will need to enter the password again.

On the touch display, you are always logged in as **User**.

On the **Login** page, not only the relevant login fields but also the instantaneous values for power, daily yield, previous-day yield and total yield are displayed.

Procedure:

1. Call up the user interface with the corresponding IP address.
   Useful hint: The IP address of the service interface is 192.168.100.1.
2. Select your login role from the drop-down list in the field **Login**.
   If you want to log in as installer, select the field **Login** in the status info line and select **Installer** from the drop-down list.
3. Enter the password in the field **Password**.
4. Select [**Login**].

9.4 Accessing the Parameter Overview

1. If you are not yet logged into the user interface, log in as installer.
2. In the main navigation, select and select **Parameter** from the drop-down list.

9.5 Calling Up the Overview for Instantaneous Values

1. If you are not yet logged into the user interface, log in.
2. In the main navigation select .
3. Select [**Instantaneous values**] in the Analysis menu.

9.6 Calling Up the Event Overview

1. If you are not yet logged into the user interface, log in as installer.
2. In the main navigation select .
   ☑ A table opens containing all events that have occurred.

10 Function Description

10.1 Operating States

10.1.1 Overview of the Operating States

The inverter cycles through various states during operation.

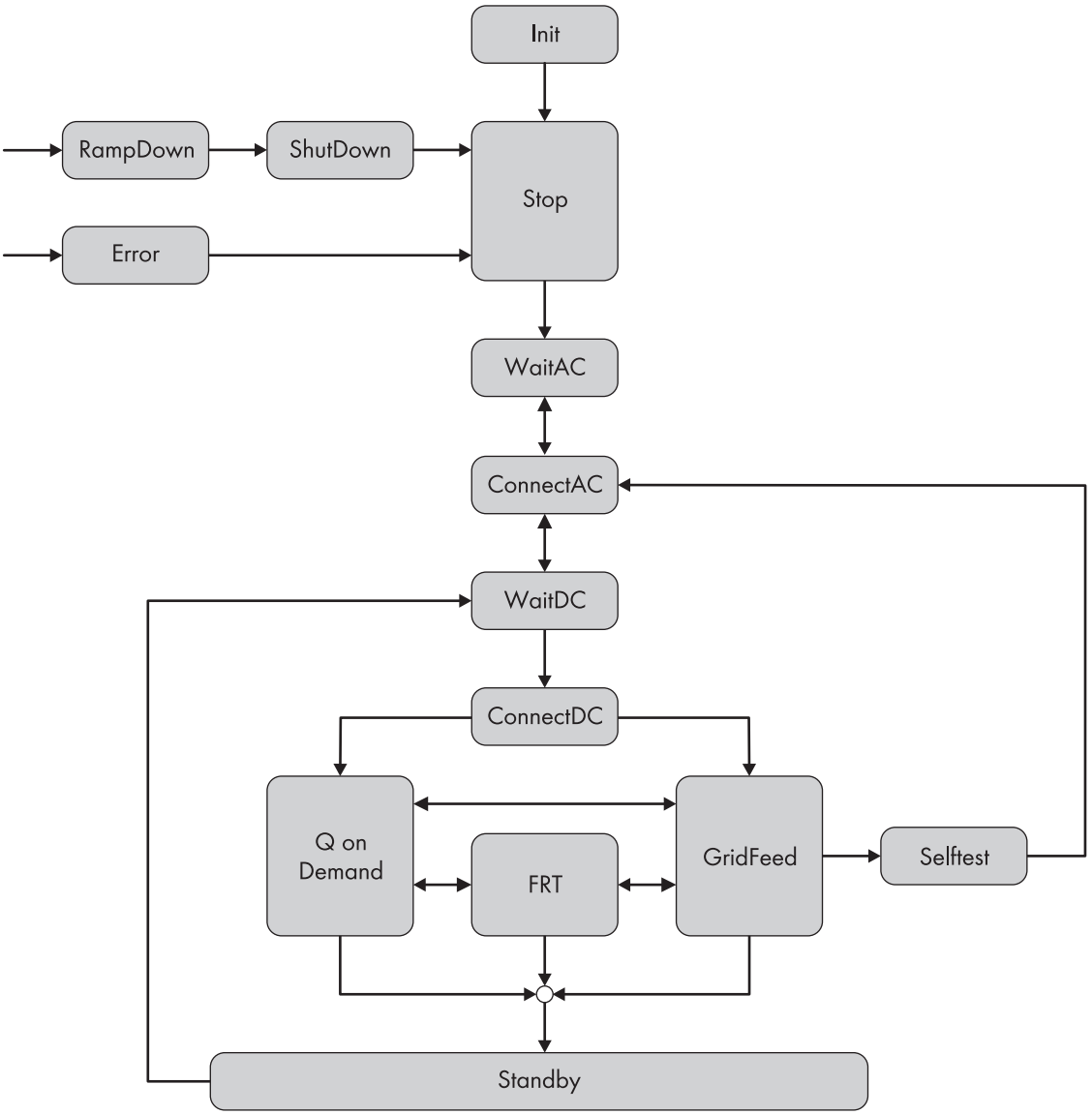


Figure 20: General overview of the operating states of the inverter

This overview shows the names of the operating states as they are displayed.

10.1.2 Stop

The inverter is switched off. The DC switchgear and the AC disconnection unit are switched off.

If the start/stop key switch **-S1** is set to **Start**, the inverter switches to the operating state "WaitAC".

10.1.3 Init

The inverter is prepared for operation and the functioning of all components is tested.

10.1.4 WaitAC

In the operating state "WaitAC", the inverter monitors the grid limits for the time defined in the parameter **WaitGriTm**. If no grid error occurs during the grid monitoring time, the inverter switches to the operating state "ConnectAC".

If the grid limits are exceeded during the grid monitoring time, the inverter remains in the operating state "WaitAC" and will restart grid monitoring.

10.1.5 ConnectAC

A valid AC grid is present in the operating state "ConnectAC" and the inverter connects to the utility grid. The inverter switches the AC disconnection unit on.

10.1.6 WaitDC

In the operating state "WaitDC", the inverter monitors the applied input voltage U_{PV} and compares it with the DC voltage necessary for operation. When the input voltage exceeds the required DC voltage, the inverter switches to the operating state "ConnectDC".

10.1.7 ConnectDC

When in the operating state "Connect DC", the inverter changes to the operating state "GridFeed" or into "Q on Demand" operation. For the operating state "GridFeed", the inverter connects the DC switchgear. In "Q on Demand" operation, the inverter starts feeding in reactive power when there is no PV power available (e.g. at night).

10.1.8 GridFeed

In the operating state "GridFeed", the inverter feeds in active power and reactive power in accordance with the requirements. The inverter operates permanently at the Maximum Power Point (MPP). The current feed-in values can be read off from the display.

If the AC power generated by the inverter falls below the minimum feed-in power of 10 kW, the inverter switches to the operating state "Standby". Inverters with the order option "Q on Demand" switch to the operating state "Q on Demand".

If a grid-voltage dip occurs in the utility grid, the inverter switches from the operating state "GridFeed" to the operating state "FRT".

If the start/stop key switch **-S1** has been set to **Stop**, the inverter switches to the operating state "RampDown".

10.1.9 Q on Demand

With the order option "Q on Demand", the inverter can provide reactive power in order to stabilize the utility grid during non-feed-in operation, e.g. at night, or to compensate for reactive power in the PV power plant. This function is independent of normal feed-in operation. In the operating state "Q on Demand", only limited dynamic grid support is available.

If the AC power generated by the inverter falls below 10 kW, the inverter switches from feed-in operation to "Q on Demand" operation. The inverter feeds in reactive power in accordance with the parameter settings. Since this status can also occur during the day, the DC switchgear remains closed at first in order to avoid unnecessary switching cycles of the DC switchgear. If the inverter is in "Q on Demand" operation for one hour or no active power is fed in, the DC switchgear opens. The inverter continues to feed in reactive power.

While the inverter is feeding in reactive power, the inverter monitors whether the conditions for active power feed-in are met. Once the feed-in requirements are met, the inverter closes the DC switchgear and switches to the operating state "GridFeed". By default, the amount of AC active current is set to −100 A to protect the PV array.

10.1.10 Standby

When the measured inverter power is below the minimum feed-in power of 10 kW and the inverter should not change to "Q on Demand" operation, the inverter interrupts the grid feed-in. The AC disconnection unit and the DC switchgear remain closed.

Depending on the configuration of the inverter, the inverter remains in this state or it switches via the "ConnectAC" operating state to the "WaitDC" operating state after a while. When switching to the "ConnectAC" operating state, the inverter opens the DC switchgear.

10.1.11 RampDown

If the start/stop key switch **-S1** has been set to **Stop**, the inverter reduces its power to below 100 kVA, disconnects from the utility grid and opens the AC disconnection unit and the DC switchgear. Then the inverter switches to the operating state "ShutDown".

10.1.12 ShutDown

Once the inverter has disconnected from the utility grid in the operating state "RampDown", all capacitors are discharged. Then the inverter switches to the operating state "Stop".

10.1.13 Error

If an error has occurred in the inverter or the MV transformer or the fast stop key switch **-S2** was pressed, the AC disconnection unit and the DC switchgear are opened immediately, the inverter disconnects from the utility grid and switches to a safe state. In this state, the capacitors remain charged.

When the inverter switches to the operating state "Error" following an error, the error must be acknowledged. Then the inverter switches to the operating state "Stop". Depending on the type of error, the error must be rectified and acknowledged manually or the error will automatically be acknowledged after an error-dependent time period.

When the inverter switches to the operating state "Error" after the fast stop key switch **-S2** was pressed, the fast stop key switch **-S2** must be switched on again manually. Then the inverter switches to the operating state "Stop".

10.1.14 Diag

To guarantee the safety of the inverter, the inverter cycles through a diagnosis test periodically. It is being checked whether the safety devices function properly.

10.1.15 FRT

If a disturbance occurs in the utility grid while the inverter is in the operating state "GridFeed", it switches to the operating state "FRT" and supports the utility grid through dynamic grid support. There are two types of grid support:

Mode	Explanation
Complete dynamic grid support	The inverter feeds in reactive current during the grid failure.
Limited dynamic grid support	The inverter interrupts feed-in operation during the grid failure.

If a disturbance occurs in the utility grid while in "Q on Demand" operation, the inverter switches to the operating state "FRT" and discontinues feeding in. Once the grid error is no longer present, reactive power is supplied immediately.

10.2 Safety Functions

10.2.1 Manual Shutdown Functions

10.2.1.1 Overview of Manual Shutdown Functions

The inverter can be shut down via various functions. As soon as one of the functions is activated, the inverter remains in the given mode. Only when all functions have been switched to operation can the inverter switch over to feed-in operation.

Function	Inverter behavior
Key switch	After actuating the key switch, the inverter switches to the operating state "Stop". In this case, the inverter disconnects from the utility grid, opens the AC disconnection unit and the DC switchgear, and discharges the capacitors.
Fast-stop key switch	After actuating the key switch of the fast stop, the inverter switches to the operating state "Stop". In this case, the inverter disconnects from the utility grid and opens the AC disconnection unit and the DC switchgear.
Parameters	The inverter can be switched to the operating state "Standby" via the parameter **RemRdy**. In this case, the inverter bridges are opened and feed-in is interrupted. The AC disconnection unit and the DC switchgear remain closed. The inverter can be switched to the "Stop" operating state via the parameter **InvOpMod**. When this happens, the AC disconnection unit and the DC switchgear open.
External standby	The inverter can be switched to the "Standby" operating state via an external signal. In this case, the inverter bridges are opened and feed-in is interrupted. The AC disconnection unit and the DC switchgear remain closed. The inverter can be switched to the "Stop" operating state via a digital signal. When this happens, the AC disconnection unit and the DC switchgear open.
External fast stop	The fast-stop function can be tripped on the inverter via a digital signal. The inverter switches immediately to the operating state "Stop". In this case, the inverter disconnects from the utility grid and opens the AC disconnection unit and the DC switchgear.

10.2.1.2 Mode of Operation of the External Fast Stop

The inverter comes equipped with a fast stop input at terminal **-X440:1.3**.

The following options are available for configuring the external fast stop:

- **External fast stop is deactivated**

  The terminals of the active fast stop are bridged. The fast stop function is thus deactivated. The terminals were bridged during production.

- **External fast stop is operated with internal or external 24 V supply**

  An external switch (break contact) is connected to the inverter terminals via the internal supply voltage or the external 24 V supply of the inverter. When the switch is closed, the relay is activated and the inverter feeds into the grid. If the fast stop is tripped, the switch opens and the relay is deactivated. The inverter is stopped and no longer feeds into the utility grid.

If the external fast stop is tripped, the AC disconnection and the DC switchgear are opened. The external fast stop does not result in rapid discharge of the capacitors.

Tripping the fast stop

The fast stop should only be tripped in case of imminent danger. Tripping of the fast stop does not entail fast discharge of the capacitors. If the inverter is to be switched off and properly shut down via an external signal, the remote shutdown input is to be used.

10.2.1.3 Mode of Operation of the External Standby

The inverter comes equipped with an external standby input at terminal **-X440:5.7**.

This function lets you switch the inverter to the "Standby" operating state from a control room, for example. The AC disconnection unit and the DC switchgear of the inverter remain closed. This makes a fast switch to the operating state "GridFeed" possible if the standby signal has been reset.

The external standby is designed as an open-circuit fail-safe function and must be connected to an external 24 V supply voltage. If 24 V is present at the external standby, the inverter continues to operate in the current operating state. If the external standby is tripped or if a wire-break occurs, 0 V is present at terminal **-X440:5.7** and the inverter switches from the current operating state to the operating state "Standby".

10.2.2 Automatic Shutdown Functions

10.2.2.1 Monitoring the Power Frequency

The inverter continuously checks the power frequency. This enables the inverter to disconnect from the utility grid in case of overfrequency or underfrequency.

If the power frequency rises above or falls below the configured thresholds, the inverter waits for the time defined in the corresponding parameter and disconnects from the utility grid.

You can set the thresholds and the delay time in the parameters. For frequency monitoring, six limits for overfrequency and six limits for underfrequency can be configured.

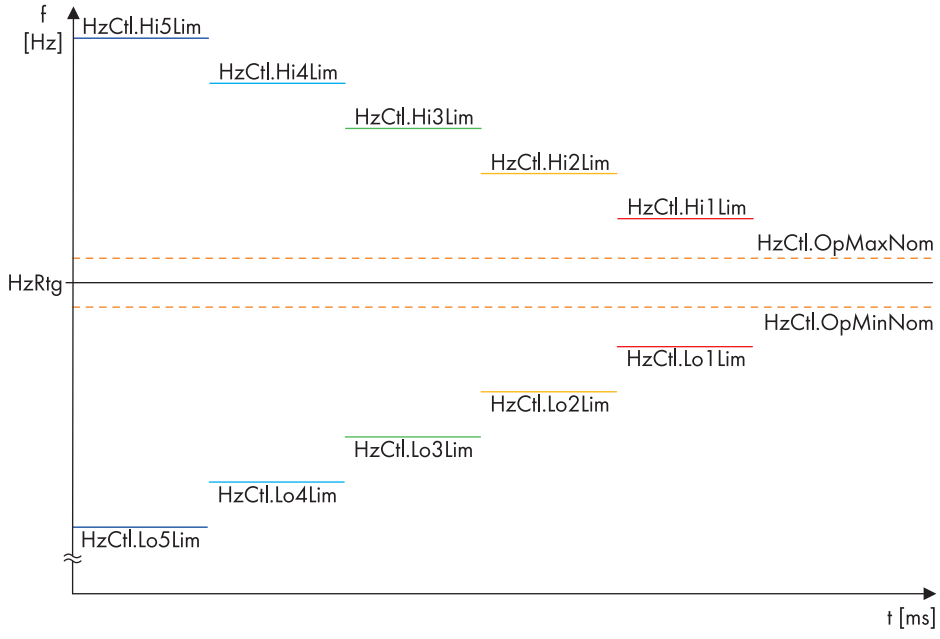


Figure 21: Monitoring of the power frequency

Parameters	Explanation	Default value
HzCtl.OpMaxNom	Frequency threshold for the upper connection limit of frequency monitoring	60.50 Hz
HzCtl.OpMinNom	Frequency threshold for the lower connection limit of frequency monitoring	59.30 Hz

Parameters	Explanation	Default value
HzCtl.Hi1Lim	First threshold for overfrequency	65.00 Hz
HzCtl.Hi1LimTm	Time lapse for the first threshold for overfrequency	160 ms
HzCtl.Hi*Lim	Threshold of the second to fifth level for overfrequency	65.00 Hz*
HzCtl.Hi*LimTm	Time lapse for the second to fifth threshold for overfrequency	10,000 ms*
HzCtl.Lo1Lim	First threshold for underfrequency	57.00 Hz
HzCtl.Lo1LimTm	Time lapse for the first threshold for underfrequency	160 ms
HzCtl.Lo2Lim	Threshold of the second level for underfrequency	57.00 Hz
HzCtl.Lo2LimTm	Tripping time for the second threshold for underfrequency	160 ms
HzCtl.Lo*LimTm	Threshold of the third to fifth level for underfrequency	55.00 Hz*
HzCtl.Lo*LimTm	Time lapse for the third to fifth threshold for underfrequency	10,000 ms*

* In this parameterization, the thresholds are deactivated.

Monitoring of the Power Frequency for Overfrequency and Underfrequency in Accordance with IEEE 1547

Termination of the operating license if setting values are changed

The thresholds for the power frequency are configured in accordance with IEEE 1547. If inverter grid monitoring is to be performed in accordance with IEEE 1547, only the parameters relevant for IEEE 1547 must be left unchanged.

If the power frequency exceeds or falls short of a defined frequency threshold, the inverter must disconnect from the utility grid within a defined time interval. In this case, the frequency thresholds as defined by relevant standards and the disconnection times form a window in which the individual parameters of the inverter must be located.

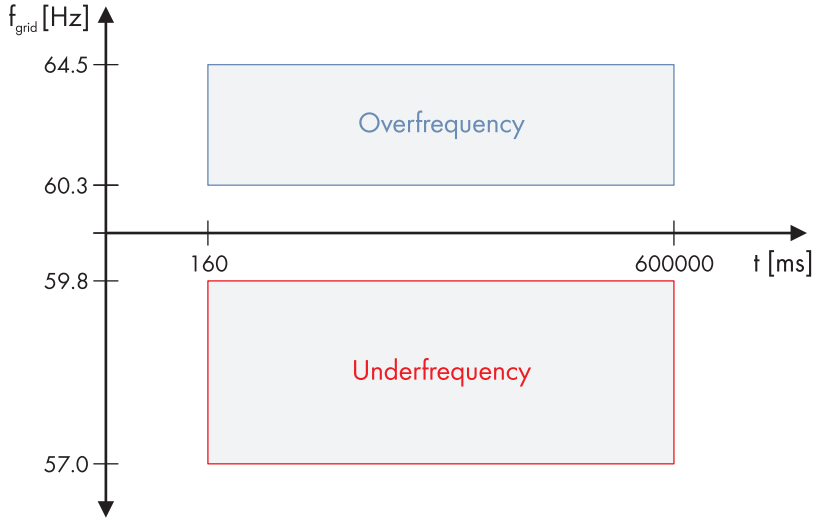


Figure 22: Range of power frequency monitoring in accordance with IEEE 1547

Implementation of power frequency monitoring in accordance with IEEE 1547 is two-tiered: there are two frequency thresholds each for overfrequency and underfrequency with corresponding monitoring times for each level. This means that at low frequency variation the power frequency can be monitored over a longer period before the inverter disconnects from the utility grid. In the event of severe infringement of the upper or lower frequency thresholds, a shorter monitoring time can be configured so that the inverter disconnects from the utility grid faster.

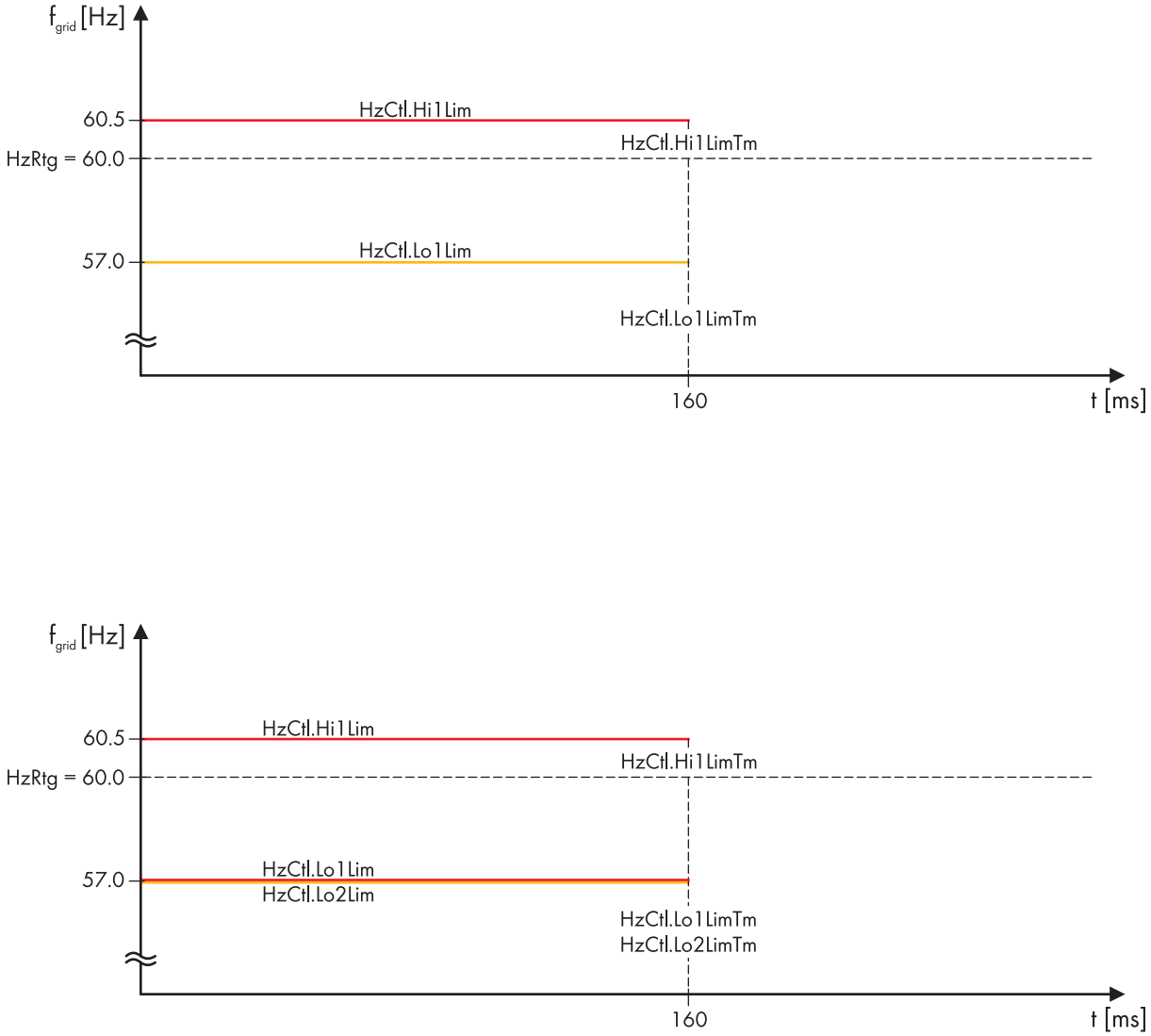


Figure 23: Parameters for monitoring the power frequency in accordance with IEEE 1547

Parameters	Explanation	Default value
HzCtl.Hi1Lim	First threshold for overfrequency	60.5 Hz
HzCtl.Hi1LimTm	Time lapse for the first threshold for overfrequency	160 ms
HzCtl.Lo1Lim	First threshold for underfrequency	57.0 Hz
HzCtl.Lo1LimTm	Time lapse for the first threshold for underfrequency	160 ms

10.2.2.2 Monitoring the Grid Voltage

The inverter continuously checks the grid voltage. This enables the inverter to disconnect from the utility grid in case or overvoltage or undervoltage.

If the grid voltage rises above or falls below the configured thresholds, the inverter waits for the time defined in the corresponding parameter and disconnects from the utility grid.

You can set the thresholds and the delay time in the parameters. For voltage monitoring, you can set five limits for overvoltage and five limits for undervoltage.

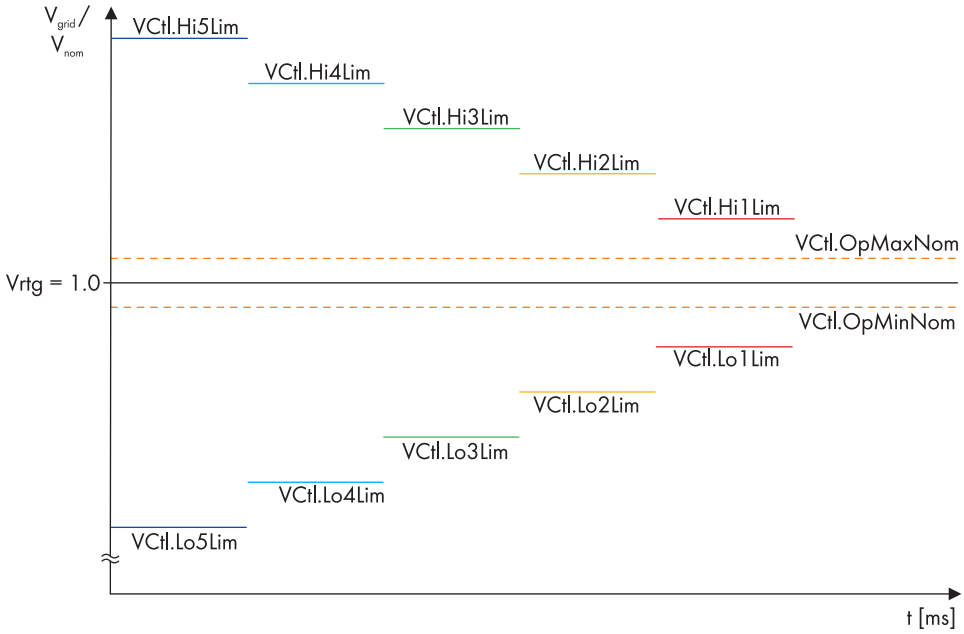


Figure 24: Monitoring of the grid voltage

Parameters	Explanation	Default value
VCtl.OpMaxNom	Voltage threshold for the upper connection limit of voltage monitoring	1.10
VCtl.OpMinNom	Voltage threshold for the lower connection limit of voltage monitoring	0.88
VCtl.Hi1Lim	First threshold for overvoltage	1.10
VCtl.Hi1LimTm	Time lapse for the first threshold for overvoltage	1,000 ms
VCtl.Hi2Lim	Threshold of the second level for overvoltage	1.2
VCtl.Hi2LimTm	Time lapse for the second threshold for overvoltage	160 ms
VCtl.Hi*Lim	Threshold of the third to fifth level for overvoltage	2.00
VCtl.Hi*LimTm	Time lapse for the third to fifth threshold for overvoltage	10,000 ms
VCtl.Lo1Lim	First threshold for undervoltage	0.88
VCtl.Lo1LimTm	Time lapse for the first threshold for undervoltage	2,000 ms
VCtl.Lo1Lim	Threshold of the second level for undervoltage	0.50
VCtl.Lo1LimTm	Time lapse for the second threshold for undervoltage	160ms
VCtl.Lo*Lim	Threshold of the third to fifth level for undervoltage	0.00
VCtl.Lo*LimTm	Time lapse for the third to fifth threshold of undervoltage	10,000 ms

Monitoring the grid voltage in accordance with IEEE 1547

Termination of the operating license if setting values are changed

The thresholds for the grid voltage are configured in accordance with IEEE 1547. If inverter grid monitoring is to be performed in accordance with IEEE 1547, only the parameters relevant for IEEE 1547 must be left unchanged.

In accordance with IEEE 1547, the grid voltage is monitored for over and undervoltage.

If the grid voltage exceeds or falls short of a defined voltage threshold, the inverter must disconnect from the utility grid within a defined time interval. In this case, the voltage thresholds as defined by relevant standards and the disconnection times form a window in which the individual parameters of the inverter must be located.

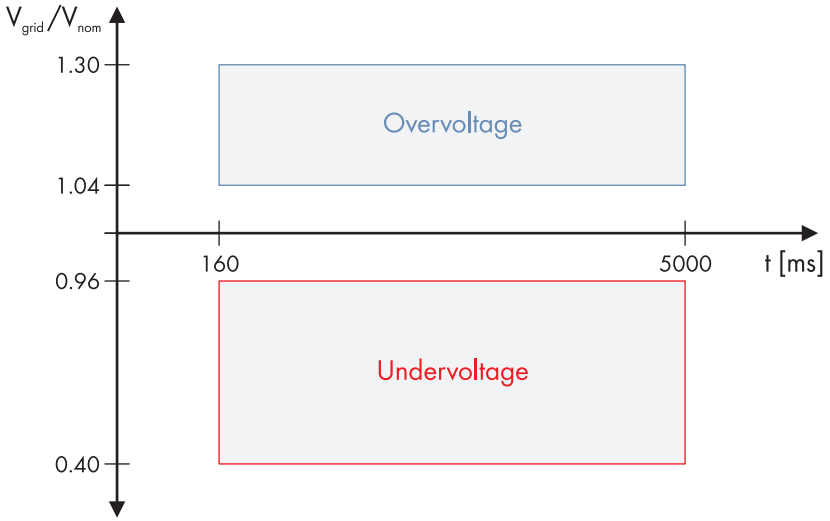


Figure 25: Range of grid voltage monitoring in accordance with IEEE 1547

Implementation of voltage monitoring is two-tiered: there are two thresholds each for over and undervoltage with corresponding monitoring times for each level. This means that at low voltage variation the grid voltage can be monitored over a longer period before the inverter disconnects from the utility grid. In the event of severe infringement of the upper or lower voltage thresholds, a shorter monitoring time can be configured so that the inverter disconnects from the utility grid faster.

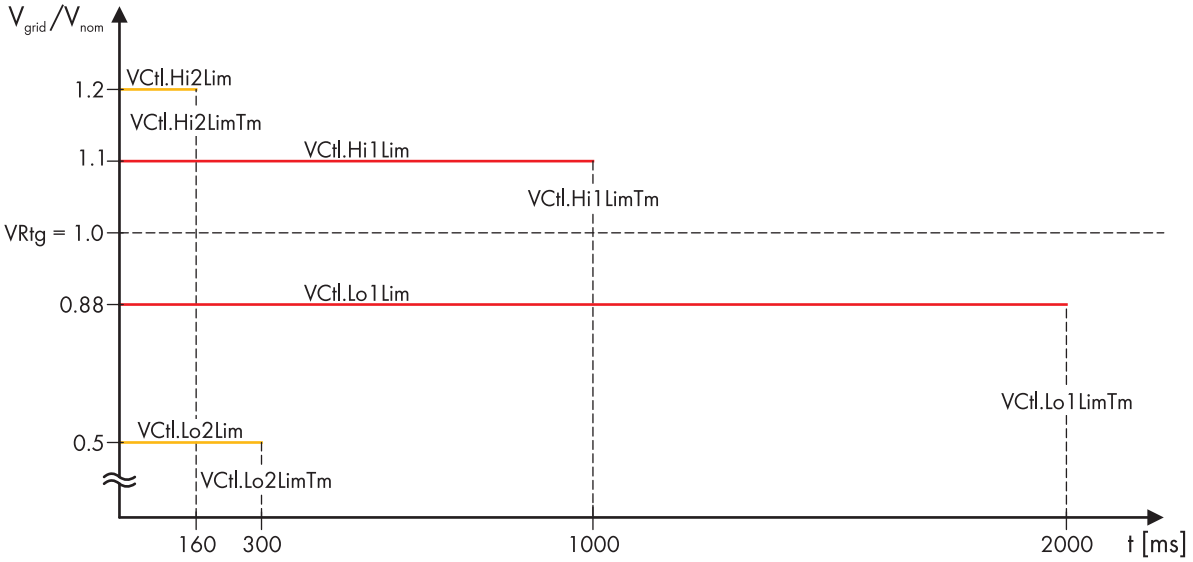


Figure 26: Parameters for monitoring the grid voltage in accordance with IEEE 1547

Parameters	Explanation	Default value
VCtl.Hi1Lim	First threshold for overvoltage	1.1
VCtl.Hi1LimTm	Time lapse for the first threshold for overvoltage	1,000 ms
VCtl.Hi2Lim	Second threshold for overvoltage	1.2
VCtl.Hi2LimTm	Time lapse for the second threshold for overvoltage	160 ms
VCtl.Lo1Lim	First threshold for undervoltage	0.88

Parameters	Explanation	Default value
VCtl.Lo1LimTm	Time lapse for the first threshold for undervoltage	2,000 ms
VCtl.Lo2Lim	Second threshold for undervoltage	0.5
VCtl.Lo2LimTm	Time lapse for the second threshold for undervoltage	160 ms

10.2.2.3 Transformer Protection

Via a plug, protective devices of the MV transformer can be connected to the inverter.

The transformer protection is implemented by individual signal generators. If the signal generators are properly connected to the inverter, the inverter is switched off in the event of an MV transformer error.

The transformer protection is usually enabled by means of protective devices with change-over contact. The inverter provides a 24 V signal. This signal can be used to supply the analog sensor and the change-over contact. The temperature of the MV transformer can be monitored with an analog temperature sensor simultaneously. The transformer protection is only active if the supply voltage is applied to the inverter.

The inverter switches immediately to the operating state "RampDown" in the event of a wire break.

The following functions can be monitored separately:

Monitoring of temperature

- **With change-over contact**

  The MV transformer sends signals to the inverter at terminals **-X4:1** and **-X4:2**.

  To guarantee safety, two temperature levels are monitored: a warning temperature and a switch-off temperature.

  If the temperature in the MV transformer exceeds the warning temperature, the protective device of the MV transformer interrupts the signal at terminal **-X4:2** and the inverter switches to the operating state "Error" via the operating state "RampDown".

  If the inverter is in the operating state "Error", the MV transformer can cool down. Once the MV transformer has cooled down sufficiently the change-over contact closes again. The error is being acknowledged once the error waiting period has passed and the inverter switches to the operating state "WaitAC". Once the feed-in conditions are fulfilled again, the inverter switches to the operating state "GridFeed".

  If the MV transformer exceeds the switch-off temperature, the protective device of the MV transformer interrupts the signal at terminal **-X4:1**. The inverter switches immediately to operating state "Error" and switches off.

  The temperature thresholds depend on the MV transformer used and must be set on the MV transformer for each individual project.

- **With analog temperature measurement**

  The inverter provides the option to record the temperature of the MV transformer using an analog sensor. The inverter converts the measured values to temperatures and sends them to the communication interface. The temperature signals can be called up via Modbus protocol at the communication interface.

  The analog temperature measurement is for informational purposes only. The inverter will not disconnect due to this analog temperature measurement.

Monitoring of boiler pressure

If the pressure in the MV transformer boiler reaches the minimum or the maximum value, the signal at terminal **-X4:4** is interrupted by the protective device of the MV transformer. The inverter switches immediately to operating state "Error" and switches off.

The pressure thresholds depend on the MV transformer used and must be set for each individual project.

Monitoring the oil level

If the MV transformer loses oil and the oil level falls below a threshold, the protective device sends the signal to terminal **-X4:5** on the inverter. Depending on the type of the MV transformer and the protective device, gas formation in the MV transformer can also be detected. If the oil level is too low or if gases appear in the MV transformer, the protective device of the MV transformer sends a signal. The inverter switches to operating state "Error" via the operating state "RampDown".

10.2.2.4 Active Islanding Detection

The islanding detection function detects the formation of stand-alone grids and disconnects the inverter from the utility grid.

Islanding can occur when at the time of utility grid failure, the load in the shut-down sub-grid is roughly equivalent to the current feed-in power of the PV power plant.

With active islanding detection, the inverter continuously checks the stability of the utility grid. If the utility grid is intact, this has no impact on the utility grid. Only if a stand-alone grid has formed will the inverter disconnect from the utility grid.

The "active islanding detection" function is not UL-certified.

To enable the active islanding detection function, contact us (see Section 13 "Contact", page 111).

10.2.2.5 Passive Islanding Detection

Depending on the order option, the inverter may be equipped with passive islanding detection. The islanding detection function detects the formation of stand-alone grids and disconnects the inverter from the utility grid.

Islanding can occur when at the time of utility grid failure, the load in the shut-down sub-grid is roughly equivalent to the current feed-in power of the PV power plant.

Unlike active islanding detection, with passive islanding detection the utility grid is not actively influenced, but simply passively monitored. This involves monitoring the speed of the frequency change.

If the power frequency changes by a certain amount in a certain time, a stand-alone grid is detected and the inverter disconnects from the utility grid. The magnitude of the frequency change and the time lapse in which this change must take place can be configured via parameters on the inverter.

The "passive islanding detection" function is not UL-certified.

10.2.2.6 External Islanding Detection

If the PV power plant is equipped with an external anti-islanding detection system with trip transfer, the formation of stand-alone grids can be detected at the farm level. If a stand-alone grid has formed, a signal is transmitted to the fast stop input of the inverter. A suitable cable must be connected at the fast stop input at terminal **-X440:1,3** of the inverter during installation.

During normal operation conditions, a 24 V signal is transmitted to the fast stop input of the inverter. If a stand-alone grid has formed, the signal switches to 0 V and the inverter switches to "Error" and is disconnected from the utility grid.

In order to switch back the inverter to the operating state "GridFeed", ensure that the external anti-islanding detection system generates the 24 V signal.

10.2.2.7 Low-Temperature Shutdown

The internal temperature and the outside temperature are monitored in the inverter so that it can be shut down if the operating temperature range is infringed.

Inverter with temperature range –25°C to +60°C

If the outside temperature falls below –25°C, the inverter switches to the operating state "Stop" in order to protect the electronic components. As soon as the outside temperature increases to –20°C, the inverter will resume feed-in operation.

Inverter with temperature range –40°C to +60°C

If the temperature in the interior of the inverter falls below –25°C, the supplementary heating element is switched on. As soon as the temperature in the interior of the inverter increases to –15°C, the supplementary heating element is switched off.

If the outside temperature falls below –40°C, the inverter switches to the operating state "Stop" in order to protect the electronic components. As soon as the outside temperature increases to –35°C, the inverter resumes feed-in operation.

10.2.2.8 Reducing the feed-in power when there are high temperatures in the inverter

The temperature inside the inverter is continuously monitored.

The inverter reduces the feed-in power when a fan in the inverter fails and the temperature in the inverter increases. Disturbance **7501**, **7502** or **7503** is displayed. The **DrtCabTmp** instantaneous value displays whether the inverter is reducing the feed-in power due to excessive temperature inside the inverter.

If the temperature in the inverter exceeds the value set in the **TmpCab.Lim** parameter, the inverter switches off and the fault **6515** is displayed.

10.2.3 Grounding and Insulation Monitoring

10.2.3.1 Mode of Operation

In grounded PV arrays

The ground-fault monitoring is implemented by means of a residual-current monitoring device. If a ground fault occurs, the residual currents are detected and interrupted.

- **Ground fault on the ungrounded terminal**

  If a ground fault occurs on the ungrounded terminal of the PV array, the normally ungrounded terminal of the PV array is grounded non-specifically by the ground fault and a residual current flows to the grounded terminal. This residual current flows through the ground-fault monitoring device, e.g. the GFDI, and triggers it.

- **Ground fault on the grounded terminal**

  The GFDI is bypassed when a ground fault occurs on the grounded terminal of the PV array. A ground fault on the grounded terminal cannot be reliably detected. If an undetected ground fault occurs on the grounded terminal, this will pose a safety risk. A further ground fault occurring on the ungrounded terminal will lead to high residual currents that cannot be interrupted by the ground-fault monitoring unit.

i Residual current monitoring in grounded systems

In order to ensure the residual current monitoring function in grounded systems, the PV array insulation must be checked at regular intervals. It is therefore advisable to use an additional insulation monitoring device in grounded systems. This will enable the insulation to be checked at regular intervals.

In ungrounded PV arrays

An insulation monitoring device constantly determines the insulation resistance using an active measurement procedure. As soon as the insulation resistance falls below the warning threshold specified in the insulation monitoring device, an insulation warning will be displayed. As a result, preventative measures can be taken before errors such as personal injury due to leakage currents or system failure occur. If the insulation resistance falls below the configured warning threshold, the inverter switches off.

10.2.3.2 GFDI

Depending on the order option, ground-fault monitoring in the inverter may be carried out via ground fault detection and interruption (GFDI). This grounds one terminal of the PV array. GFDI is performed via a high-performance K-type circuit breaker with an operating current of 5 A. The GFDI is integrated in the inverter and connected between an input busbar and the grounding busbar.

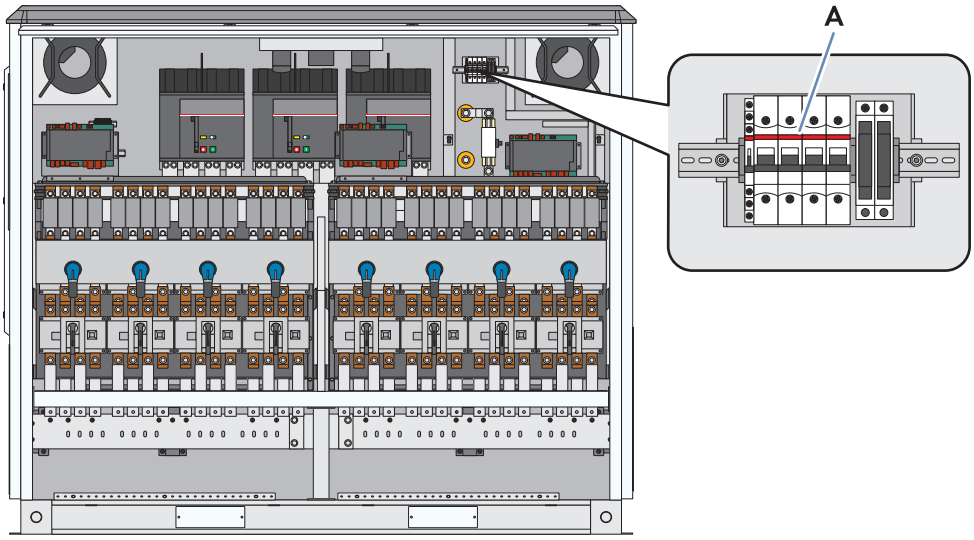


Figure 27: Position of the GFDI

Position	Designation
A	GFDI

10.2.3.3 Remote GFDI

Depending on the order option, ground fault monitoring in the inverter may be carried out via ground fault detection and interruption with motor drive, in short "Remote GFDI". This grounds one terminal of the PV array. Remote GFDI also enables automatic error processing. This reduces downtimes and avoids service calls due to temporary insulation errors such as when condensation occurs on the PV modules. Remote GFDI is performed via a high-performance K-type circuit breaker with an operating current of 5 A. The remote GFDI is integrated in the inverter and connected between an input busbar and the grounding busbar.

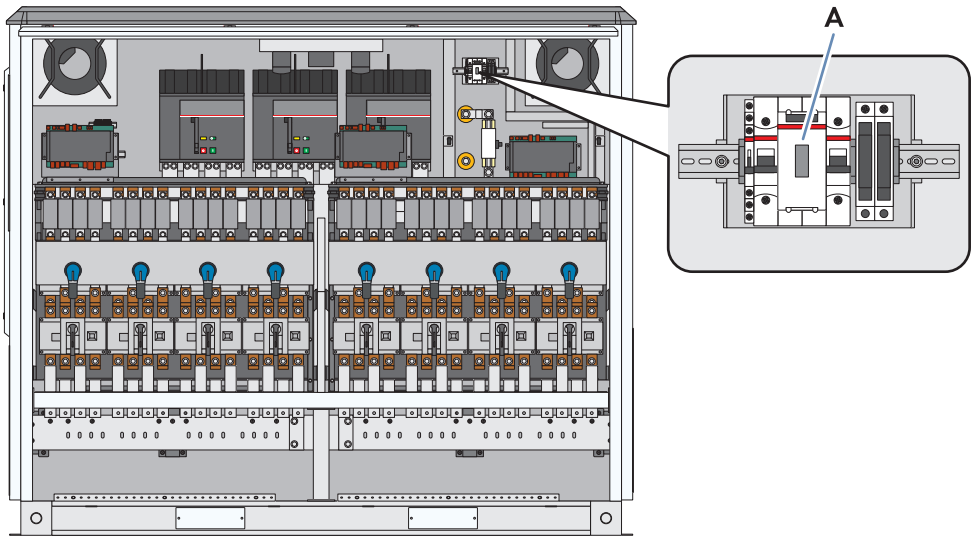


Figure 28: Position of the remote GFDI

Position	Designation
A	Remote GFDI

If the Remote GFDI trips, initially a temporary error will be assumed and a motor drive will close the Remote GFDI after a defined waiting time. No external switch command is required to close the tripped Remote GFDI. The inverter can switch back to feed-in operation after a waiting time. In the default setting of the inverter, the software will attempt to start the Remote GFDI up to three times per day. If the Remote GFDI is tripped on several consecutive days, the software assumes a permanent insulation error and the inverter will no longer switch back on. In this case, a qualified person will need to check and, if necessary, repair the insulation and then acknowledge the error.

10.2.3.4 Insulation Monitoring Device

Depending on the order option, an insulation monitoring device can monitor the insulation resistance of the PV power plant in ungrounded PV arrays.

In the operating state "GridFeed", the insulation resistance of the entire system, from the PV array to the MV transformer, will be measured.

If the inverter is in the operating states "Stop" or "WaitAC", only the insulation resistance from the PV array to the inverter will be measured.

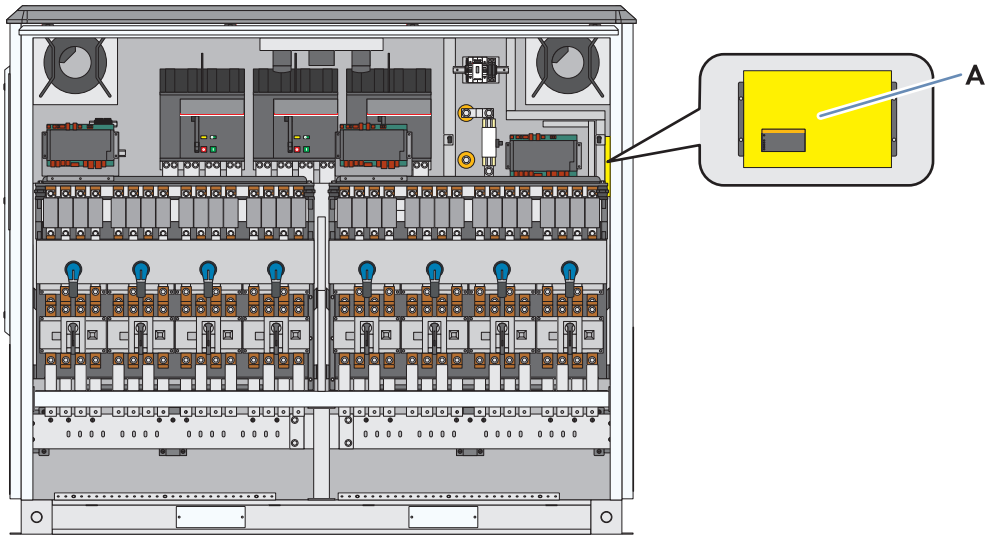


Figure 29: Position of the insulation monitoring device

Position	Designation
A	Insulation monitoring device

The insulation monitoring device is connected between the PV voltage and the grounding conductor.

If the insulation resistance falls below the threshold specified in the parameter **PvGnd.RisIsoWarnLim**, a warning is generated. The measuring circuit closes and the LED **ALARM1** on the insulation monitoring device glows. The inverter displays the disturbance message **3601** and continues feeding in. The orange light repeater at the inverter's control panel flashes.

If the insulation resistance falls below the threshold specified in the parameter **PvGnd.RisIsoErrLim**, an insulation error is generated. The measuring circuit closes and the LEDs **ALARM1** and **ALARM2** on the insulation monitoring device glow. The inverter displays the disturbance message **3501** and switches to the operating state "Error". The red light repeater at the inverter's control panel is lit.

Type of insulation monitoring device used

The insulation monitoring device used is the A-ISOMETER iso-PV1685 device supplied by Bender GmbH & Co. KG.

10.2.3.5 GFDI and Insulation Monitoring Device

10.2.4 String-Current Monitoring

10.3 Power Control

10.3.1 Power Control in the PV Power Plant

The PV power plant supports the stability of the utility grid by controlling the power fed in. The inverter can process various specifications for the control:

- Parameters that are entered via the user interface
- Specifications of the electric utility company that are transmitted per Modbus protocol
- Output values calculated in the inverter for controlling the inverter
- Adjusted substitute values for further operation in the event of a communication error

Using these values, the inverter can calculate setpoints for the active power and the reactive power to be fed in and the inverter can then feed in the appropriate power. These values are constantly being compared with the nominal values set in the inverter for active power, reactive power and apparent power and limited to them.

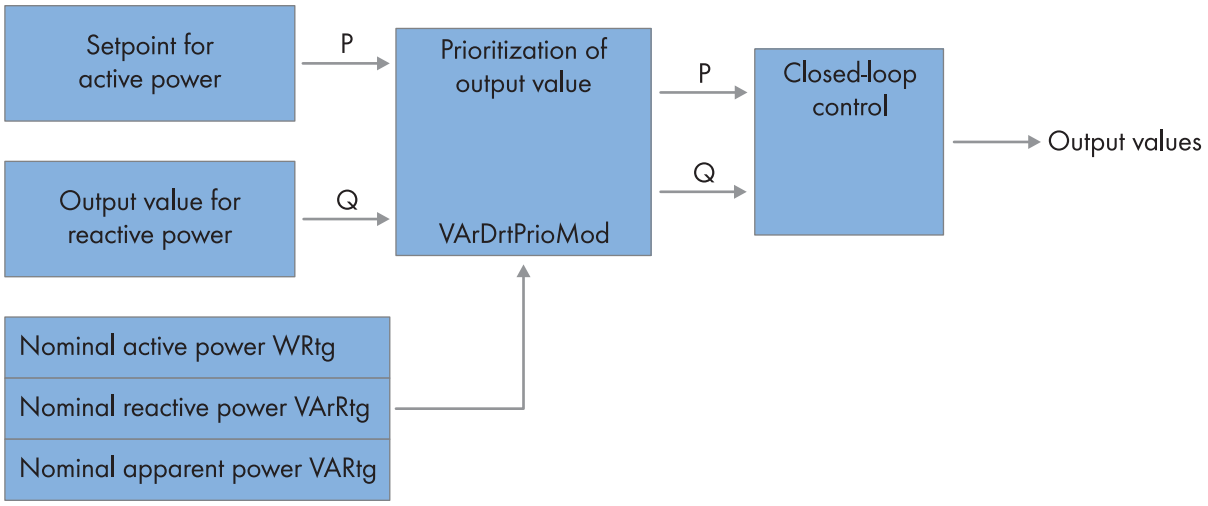


Figure 30: Principle of Power Control

In order to meet the requirements of the electric utility company, it can be adjusted in the parameter **VArDrtPrioMod** whether the reduction of the active power or the control of the reactive power should have priority.

10.3.2 Active Power Limitation

10.3.2.1 Principle of Active Power Limitation

The output value for the active power limitation is calculated using two setpoints.

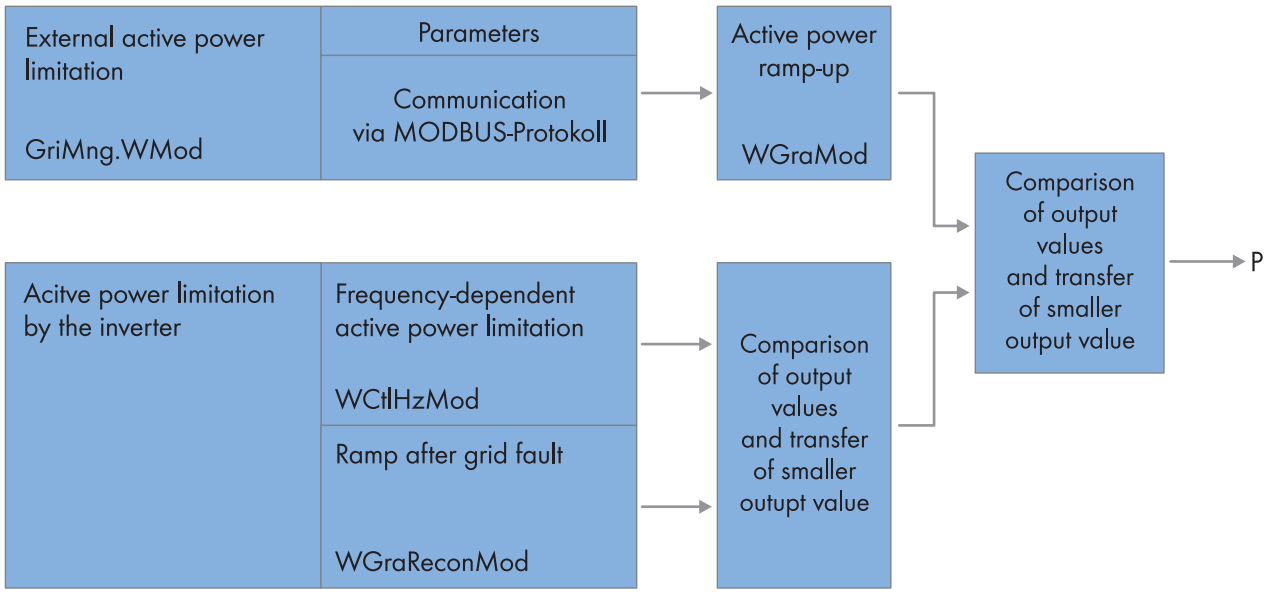


Figure 31: Principle of Active Power Limitation

The inverter receives external specifications for the active power in parameter **GriMng.WMod**. The following specifications can be set via this parameter:

- **Off** - The inverter does not control the active power via external specifications.
- **WCtlMan** - Parameters that are entered via the user interface
- **WCtlCom** - Specifications of the electric utility company that are transmitted via Modbus protocol
- Ripple control signals via the analog inputs of the inverter

The inverter processes the external setpoints when the intervals between data transmissions are greater than 50 ms.

The inverter can start the specified active power feed-in using a ramp. This means that the inverter gradually increases the ratio of feed-in power per second by the value set in the parameter **WGra**. The ramp is activated and deactivated in the **WGraMod** parameter.

At the same time, the inverter processes the specifications that were set on the inverter for the frequency-dependent active power limitation via the parameter **WCtlHzMod**.

Following a grid error, the inverter starts to feed-in power with the ramp set up in the parameter **WGraRecon**.

The inverter control internally compares the specifications for reducing the active power and generates the output value for the active power reduction using the smaller value.

10.3.2.2 Active Power Limitation via Parameters

The active power limitation is entered as an absolute value via the parameter **WSptMan**. The parameter **WSptMan** defines the amount of active power to be fed in and can be changed during feed-in operation. The parameter **WSptMan** must not be greater than the parameter **WRtg**.

10.3.3 Reactive Power Control

10.3.3.1 Principle of Reactive Power Control

The output value for the reactive power control is calculated using two output values.

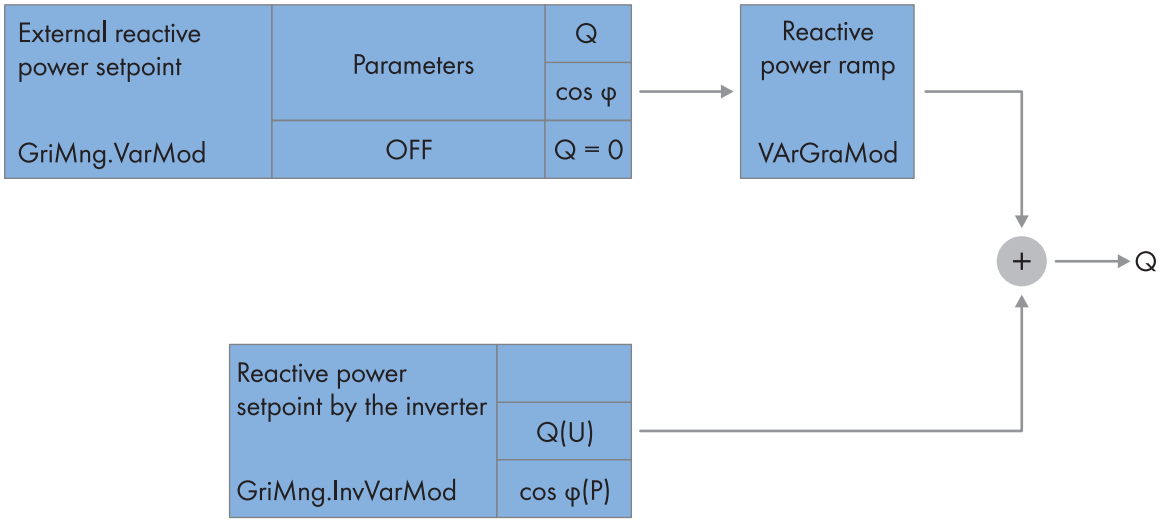


Figure 32: Principle of Reactive Power Control

The inverter receives external specifications for the reactive power in the parameter **GriMng.VarMod**. The following specifications can be set via this parameter:

- **Off** - The inverter does not provide reactive power.
- **VArCtlCom** - Specifications of the electric utility company for the reactive power values transmitted via Modbus protocol.
- **PFCtlCom** - Specifications of the electric utility company for the displacement power factor transmitted via Modbus protocol
- **VArCtlMan** - Entry of reactive power via fixed specification defined in parameter **VArSptMan**
- **PFCtlMan** - Entry of displacement power factor via fixed specification defined in parameter **PFSptMan**
- Parameters that are entered via the user interface
- Specifications of the electric utility company that are transmitted via Modbus protocol
- Ripple control signals via the analog inputs of the inverter

A reactive power value or the displacement power factor can each be transmitted.

The inverter processes the external setpoints when the intervals between data transmissions are greater than 50 ms.

The inverter can feed the specified reactive power into the utility grid using a ramp. This means that the inverter gradually increases the reactive power by the value set in the **VArGra** parameter. The ramp is activated and deactivated in the **VArGraMod** parameter.

At the same time, the inverter processes the specifications set up right on the inverter for reactive power control via the parameter **GriMng.InvVarMod**. The following specifications can be set via this parameter:

- **Off** - The inverter does not provide reactive power.
- **VArCtlVol** - The inverter controls the reactive power as a function of the voltage(see Section 10.4.4, page 94).
- **PFCtlW** - The inverter controls the reactive power via the displacement power factor as a function of the active power.

The inverter control adds up both reactive power setpoints and feeds the sum of the reactive power into the utility grid.

10.3.3.2 Reactive Power Control via Parameters

The reactive power setpoint is set via the parameter **VArSpnMan**. The parameter **VArSpnMan** is permitted to be within the range from **−VArRtg** to **+VArRtg**.

The reactive power setpoint is set via the parameter **PFSpnMan**. Here you need to enter the value of the displacement power factor and the type of excitation.

10.3.4 Inverter Behavior in Case of Communication Disturbances

In the parameters **GriMng.WMod** and **GriMng.VArMod** you can make the configuration for the inverter to receive the control setpoints via Modbus protocol. If these setpoints for active and reactive power control fail, the inverter waits for the time set in the parameter **GriMng.ComFltTmLim** after which the failure is classified as a communication error. The behavior of the inverter can be individually defined for the failure of active power and reactive power setpoints.

As long as the inverter does not receive any updated default values, it will feed power to the grid according to the settings made for missing active and reactive power setpoints. In this case, different substitute values can be configured for feed-in operation and grid monitoring. Once the time set in the parameter **GriMng.ComFltFlbTmLim** has expired, the inverter switches to the operating state "Standby" and discontinues grid feed-in. If the parameter **GriMng.ComFltFlbTmLim** is set to **0** and the use of substitute values is configured, the inverter will operate permanently using the substitute values and will not switch to the operating state "Standby". Only when the inverter receives a signal canceling the communication error will the inverter switch back to the operating state "GridFeed".

Missing active power setpoint

The behavior of the inverter in case of failure of the active power setpoint is configured in the parameter **GriMng.FltFlbWMod**:

- **Standby** - The inverter switches to the operating state "Standby" and discontinues grid feed-in.
- **W** - The inverter feeds in a fixed active power value based on a substitute value. The substitute value for active power is configured in parameter **WSptFlb**.
- **Last setpoint** - The inverter uses the last known setpoint.

Missing reactive power setpoint

The behavior of the inverter in case of failure of the reactive power setpoint is configured in the parameter **GriMng.FltFlbVArMod**:

- **Standby** - The inverter switches to the operating state "Standby" and discontinues grid feed-in.
- **PF** - The inverter feeds in with a substitute value for the displacement power factor. The substitute value for the displacement power factor is configured in parameter **PFSptFlb**.
- **VAr** - The inverter feeds in using a substitute value for a fixed reactive power. The substitute value for the displacement power factor is configured in parameter **VArSptFlb**.
- **Last setpoint** - The inverter uses the last known setpoint.

10.4 Grid Management Services

10.4.1 Start-Up Behavior

10.4.1.1 Start-Up in Normal Operation

It can be defined in the **WGraMod** and **VArGraMod** parameters whether the inverter gradually ramps up to the set active power and reactive power after a parameter change. This means that the inverter increases the power per second in steps according to the parameter settings.

Parameters	Description
WGra	The maximum feed-in power is increased by the configured amount per second.
VarGra	The configured reactive power is increased by the configured amount per second.

10.4.1.2 Start-Up after Grid Fault

In parameter **WGraReconMod**, you can define how the inverter is to begin with active power feed-in after a grid fault:

Parameters	Description
Disable	The inverter reverts to maximum power within one second.
Enable	The inverter restarts using a ramp of max. 10% of nominal power per minute. The gradient of this ramp is defined in parameter **WGraRecon**.

10.4.2 Dynamic Grid Support (FRT)

10.4.2.1 Principle of Dynamic Grid Support

With dynamic grid support (Fault Ride Through – FRT), the inverter supports the utility grid during a brief grid-voltage dip (Low Voltage Ride Through – LVRT) or during a short period of overvoltage (High Voltage Ride Through – HVRT).

With full dynamic grid support, grid support is ensured by feeding in reactive current.

With limited dynamic grid support, the inverter interrupts grid feed-in during a grid instability without disconnecting from the utility grid.

i Q on Demand and dynamic grid support

In the operating state "Q on Demand", limited dynamic grid support is available.

The inverter behavior can be set via the parameter **Frt.Mod**.

Parameter	Description
Disable	Dynamic grid support is deactivated.
Full	Complete dynamic grid support is activated.
Partial	Limited dynamic grid support is activated.

The grid limits and deactivation delays vary depending on the country standard and can be set via parameters.

10.4.2.2 Complete Dynamic Grid Support

The inverter can support the utility grid during a brief grid-voltage dip by injecting reactive current.

If the grid voltage is outside a defined range for a certain time, the inverter feeds in reactive current both in case of undervoltage and in case of overvoltage.

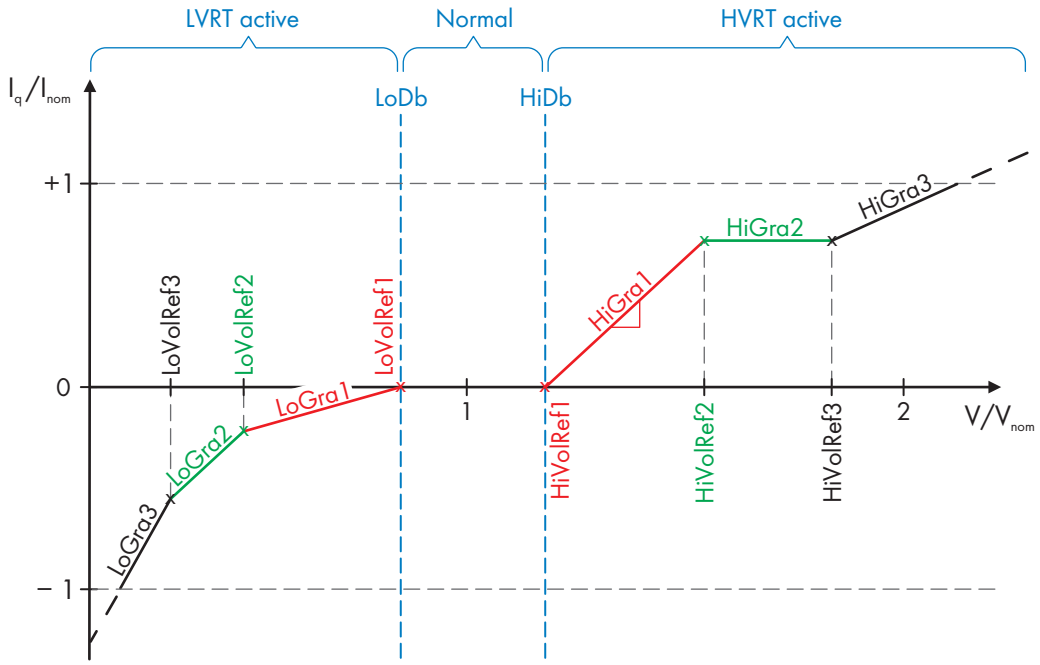


Figure 33: Characteristic curve of full dynamic grid support

Two ranges each with different gradients can be defined for undervoltage and overvoltage in the characteristic curve.

Parameters	Description
Frt.LoDb	Lower threshold for the voltage band in which dynamic grid support is not required
Frt.HiDb	Upper threshold for the voltage band in which dynamic grid support is not required
Frt.WaitTm	Duration for which grid support is active once grid voltage has returned to the voltage band
Frt.LoVolRef1	First reference value of undervoltage up to which the corresponding gradient is effective
Frt.LoVolRef2	Second reference value of undervoltage up to which the corresponding gradient is effective
Frt.LoVolRef3	Third reference value of undervoltage up to which the corresponding gradient is effective
Frt.LoGra1	First gradient of current change which is effective up to the corresponding reference value
Frt.LoGra2	Second gradient of current change which is effective up to the corresponding reference value
Frt.LoGra3	Third gradient of current change which is effective up to the corresponding reference value
Frt.HiVolRef1	First reference value of overvoltage from which the corresponding gradient is effective
Frt.HiVolRef2	Second reference value of overvoltage from which the corresponding gradient is effective
Frt.HiVolRef3	Third reference value of overvoltage from which the corresponding gradient is effective
Frt.HiGra1	First gradient of current change which is effective from the corresponding reference value
Frt.HiGra2	Second gradient of current change which is effective from the corresponding reference value
Frt.HiGra3	Third gradient of current change which is effective up to the corresponding reference value

Parameters	Description
Frt.AmpDGra	Rate of current increase with which the active power feed-in continues after grid support ends.
Frt.VolFilMod	Definition of the reference value during grid support: The voltage refers to the nominal voltage. The voltage refers to a filtered value of the measured voltage.

10.4.2.3 Limited Dynamic Grid Support

With limited dynamic grid support, the inverter interrupts grid feed-in during grid instability for a configurable time without disconnecting from the utility grid. The duration for which the inverter interrupts feed-in can be set in the parameter **Frt.WaitTm**.

10.4.3 Active Power Limitation Depending on Power Frequency: Procedure WCtlHz

In the case of active power limitation depending on power frequency, the inverter constantly checks the connected power frequency and if necessary regulates the active power feed-in.

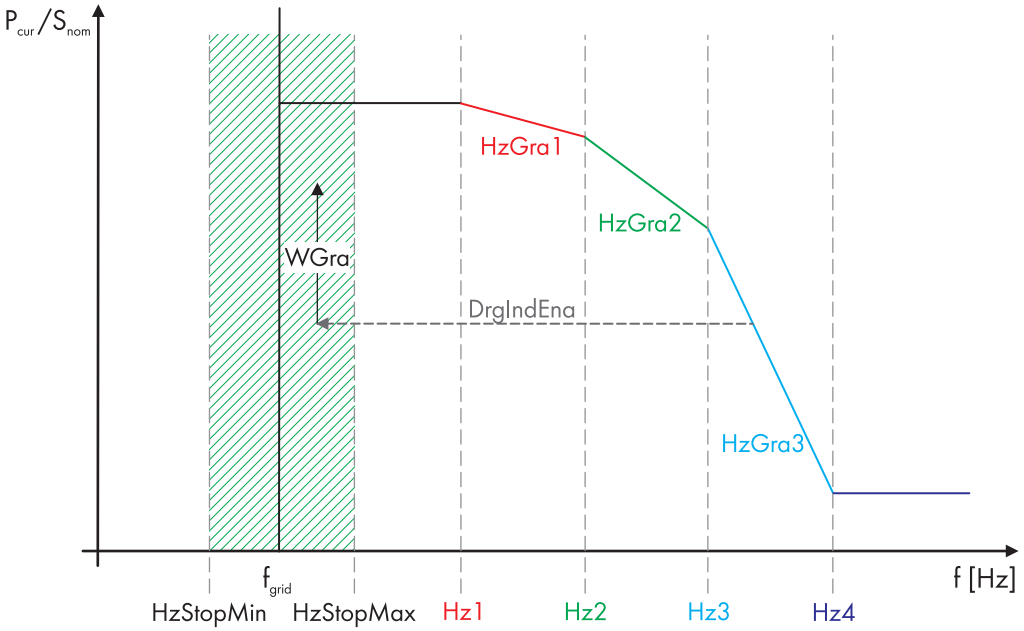


Figure 34: Active Power Limitation Depending on Power Frequency

If the power frequency exceeds a defined threshold, the inverter reduces the active power feed-in. It can be selected whether the active power should be reduced by a gradient or a set power. This reduction of active power depending on power frequency can be defined for three frequency bands. The active power reduction can be configured individually for each frequency band. This fulfills the requirements of the electric utility company.

If the power frequency exceeds the grid limit, the inverter will shut down and switch to the operating state "WaitAC". The inverter will remain in the operating state "WaitAC" until all feed-in conditions are fulfilled again. The behavior of the inverter during restart after a grid fault can be defined individually for each project (see Section 10.4.1.2, page 90).

According to the given requirement, it is possible to define how the inverter should react if the power frequency drops before the grid limit has been reached. If this definition stipulates that the inverter is to retain the active power reduction even when power frequency drops, the power frequency must first range within a so-called "rebound" zone for a defined time interval before the frequency-dependent active power reduction is suspended. When the inverter can feed in again at full active power, you can define how the inverter is to revert to full active power.

Overview of the relevant parameters

Parameters	Description
WCtlHzMod	Activation of frequency-dependent active power limitation • **Disable** – process deactivated • **Enable** – process activated
WCtlHz.RefMod	Selection of the active power to be used as a reference for the active power reduction • **W** - Reduction is based on the instantaneous active power at the time of shortfall of the frequency threshold • **WNom** - Reduction is based on the nominal active power of the inverter (**WRtg**) • **VANom** - Reduction is based on the nominal apparent power of the inverter (**VARtg**)
WCtlHz.CfgMod	Selection of the reference values for the reduction • **HzGra** - Active power reduction takes place according to a reduction gradient. • **W** - Active power reduction takes place based on power values which the inverter should attain at the end of each frequency band
WCtlHz.DrgIndMod	Selection of inverter behavior when power frequency drops • **Disable** – The inverter increases its active power fed in along the characteristic curve. • **Enable** – The inverter still feeds in using the value of active power last fed in even when the power frequency is dropping. Only when the frequency defined in the parameter **WCtlHz.HzStopMax** is not met, may the power fed in be increased again.
WCtlHz.Hz1/Hz2/Hz3	Frequency threshold of the given frequency band for frequency-dependent active power reduction
WCtlHz.HzGra1/HzGra2/ HzGra3	Gradient of the active power limitation for the given frequency band
WCtlHz.W2/W3/W4	Active power setpoint to be attained at the end of the given frequency band
WCtlHz.HzStopMax	Upper frequency threshold of the rebound zone, from which active power limitation is suspended
WCtlHz.HzStopMin	Lower frequency threshold of the rebound zone, from which active power limitation is suspended
WCtlHz.HzStopTm	Minimum time interval for which the power frequency must be stable in the rebound zone before active power limitation is suspended
WCtlHz.WGraPosEna	Selection of behavior during restart of full active power • **0** - The inverter rapidly reverts to maximum active power. • **1** - The inverter gradually ramps up to the active power.
WCtlHz.WGraPos	Gradient for the ramp by which the inverter ramps up to the maximum active power

10.4.4 Reactive Power Control as a Function of Grid Voltage: VArCtlVol Mode

The reactive power is controlled as a function of the grid voltage. By supplying reactive power, the inverter performs voltage-stabilizing measures in the event of overvoltage or undervoltage. The parameterization is carried out by means of a reactive power/voltage characteristic curve. The characteristic curve can be flexibly configured by parameterizing the slope and a type of deadband through two voltage points.

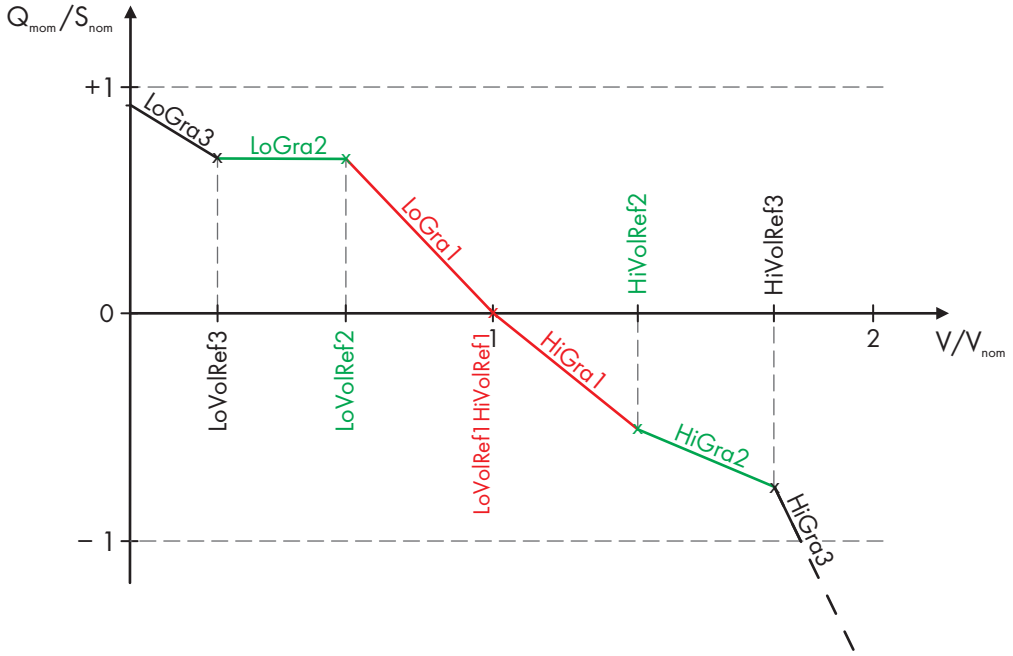


Figure 35: Characteristic curve of the voltage-dependent reactive power control

A quotient is derived from the ratio of grid voltage to nominal voltage.

When the grid voltage is equal to the defined nominal voltage, the reactive power feed-in is zero. If the grid voltage changes and exceeds or falls short of a defined threshold, the inverter reacts according to the voltage/reactive power characteristic curve by adjusting its reactive power feed-in. For each voltage quotient three thresholds can be configured, and the gradients of the reactive power adjustment for decreasing or increasing grid voltage can be defined individually for each threshold.

Overview of the relevant parameters

Parameter	Description
VArCtlVol.LoVolRef1HiVolRef1	Voltage quotient at which reactive power feed-in is zero
VArCtlVol.HiVolRef2/HiVolRef3	Threshold of the voltage quotient at increased grid voltage
VArCtlVol.HiGra1/HiGra2/HiGra3	Gradient of reactive power adjustment of the given voltage band at increased grid voltage
VArCtlVol.LoVolRef2/LoVolRef3	Threshold of the voltage quotient at reduced grid voltage
VArCtlVol.LoGra1/LoGra2/LoGra3	Gradient of reactive power adjustment of the given voltage band at increased grid voltage
VArCtlVol.VArSptFilTm	Filter constant by which the measured values of the grid voltage are filtered This enables more stable control.

10.4.5 Reactive Power Control as a Function of Active Power: PFCtlW Mode

In the **PFCTLW** mode, the displacement power factor is set as a function of feed-in power. This dependency is depicted by a freely configurable cos φ(P) characteristic curve.

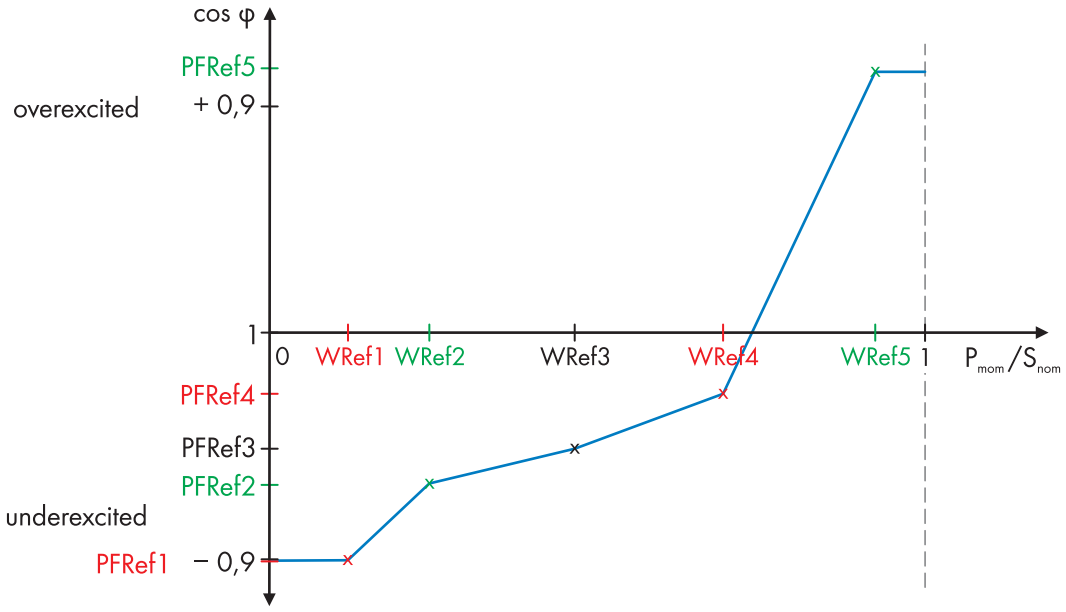


Figure 36: Reactive power control as a function of active power (example)

To implement the requirements of the grid operator as exactly as possible, the characteristic curve can be divided into four sectors, each with an individual gradient, based on five reference value pairs. The characteristic curve should be defined as monotonically increasing. The start and end points of the characteristic curve as well as the reference values of the displacement power factor can be configured by means of parameters.

If not all reference values are used, the cos φ values of the following parameters must be set to the cos φ value of the last required point of the characteristic curve. Furthermore, the reference value of the active power of the last required point of the characteristic curve should be set to **1**. All other reference values for active power are automatically set to **1**.

Parameter	Description
PFCtlW.VolMod	Activation of the voltage band in which reactive power control should be effective
PFCtlW.VolDsaPF	Reference point of the displacement power factor for activating the voltage band
PFCtlW.VolEnaVol	Activation voltage
PFCtlW.VolDsaVol	Deactivation voltage
PFCtlW.VolEnaTm	Waiting time for which the activation voltage must be present before reactive power control is activated
PFCtlW.VolDsaTm	Waiting time for which the deactivation voltage must be present before reactive power control is deactivated
PFCtlW.WRef1	First reference point of the active power on the characteristic curve
PFCtlW.PFRef1	First reference point of the displacement power factor on the characteristic curve
PFCtlW.WRef2	Second reference point of the active power on the characteristic curve
PFCtlW.PFRef2	Second reference point of the displacement power factor on the characteristic curve

Parameter	Description
PFCtlW.WRef3	Third reference point of the active power on the characteristic curve
PFCtlW.PFRef3	Third reference point of the displacement power factor on the characteristic curve
PFCtlW.WRef4	Fourth reference point of the active power on the characteristic curve
PFCtlW.PFRef4	Fourth reference point of the displacement power factor on the characteristic curve
PFCtlW.WRef5	Fifth reference point of the active power on the characteristic curve
PFCtlW.PFRef5	Fifth reference point of the displacement power factor on the characteristic curve

10.5 Communication

10.5.1 Communication Network in Cluster Ring with One Managed Switch

To set up a redundant network with several devices, a managed switch must be present in the inverter.

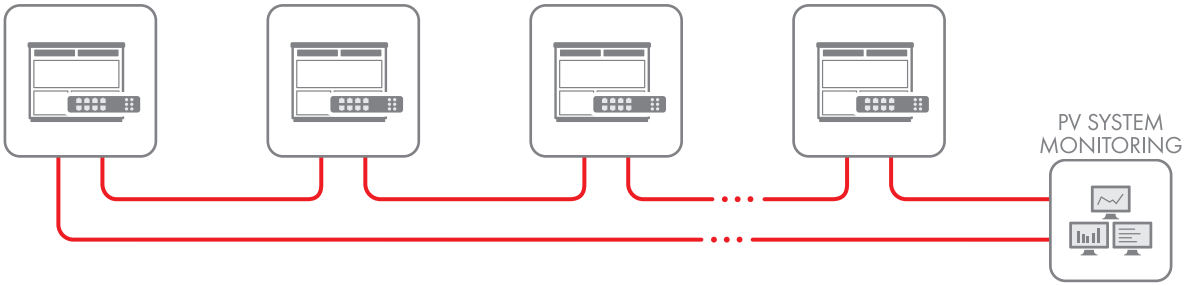


Figure 37: Inverter in cluster ring

The managed switch provides the option to set up a network with optical fibers via LAN 2 and to connect a customer communication system to the terminal **LAN 2 Port 4**. A connection of two ports of the managed switch to a splice box has been factory-set internally to which two optical fibers can be connected for the communication system A.

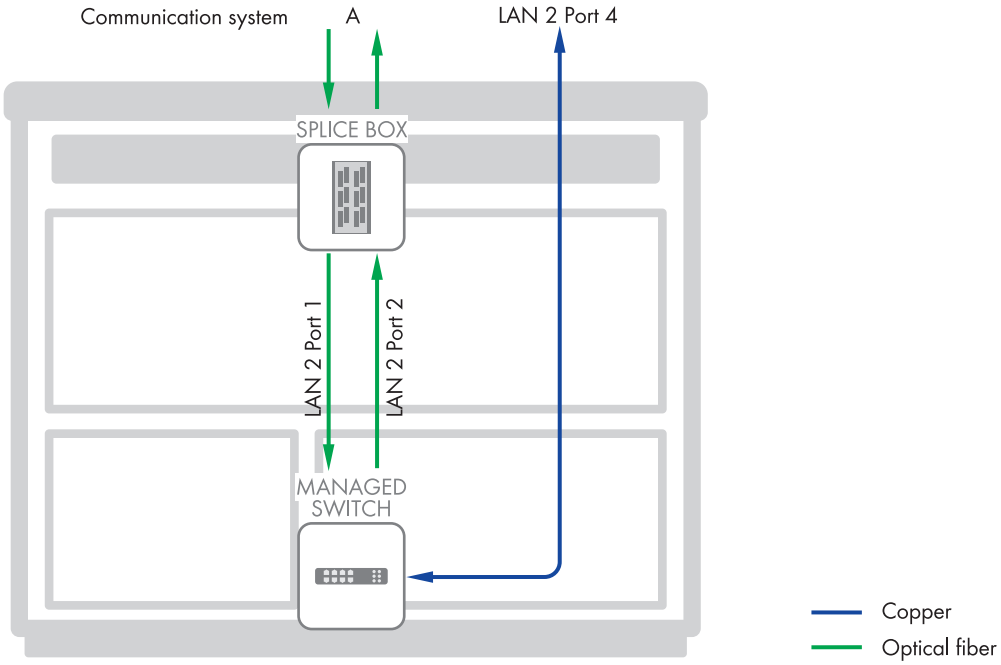


Figure 38: Inverter with one managed switch

In order to guarantee the implementation of control commands, the network that manages the control should be kept free from applications with a high network load, e.g. webcams. Using a separate network is recommended to implement data-heavy applications.

For a stable transmission of Modbus protocols, the frequency of the Modbus requests may not exceed 1/100 ms.

10.5.2 Communication Network in Backbone Ring with Two Managed Switches

To ensure a safe and fast system network in large-scale PV power plants, it is recommended to set up the system network with a ring coupling. Several cluster rings are coupled to a backbone ring.

In the cluster ring, ports 1 and 2 must be connected in each case. One of the managed switches in the cluster ring must be set up as the ring manager which controls the direction of the data flow. We recommend that the managed switch at the coupling point assumes this task.

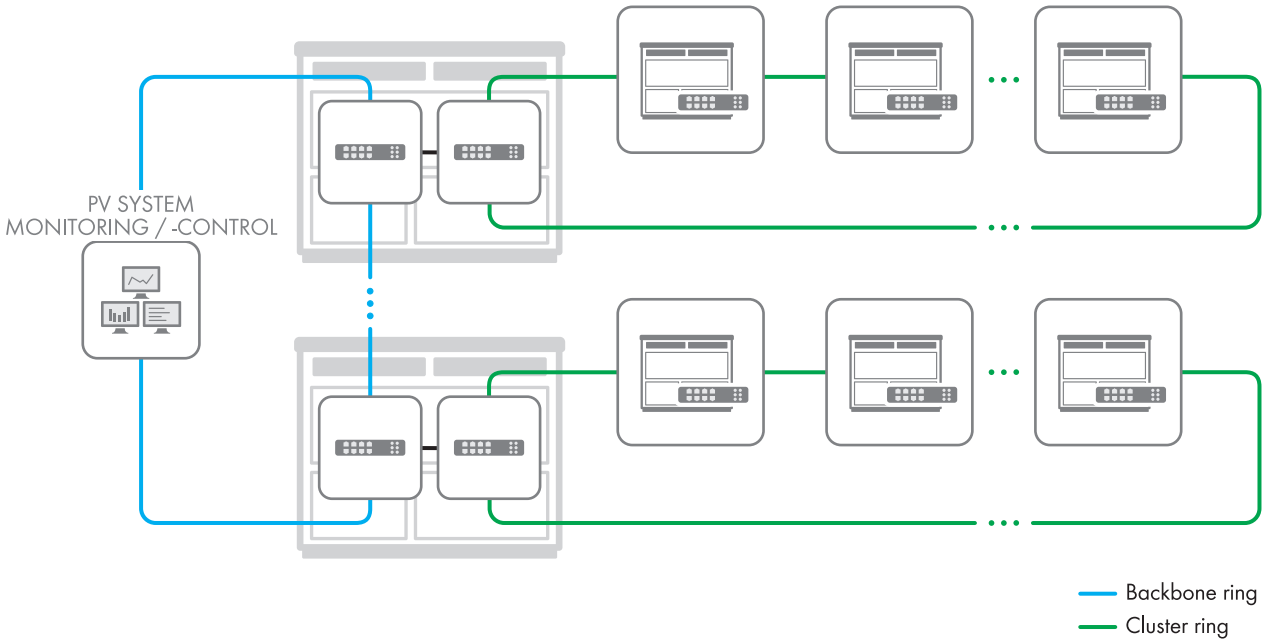


Figure 39: Communication network with backbone ring and cluster ring

The inverters at the coupling points must each contain two managed switches: one switch for the cluster ring in communication network A and one switch for the backbone ring in communication network B. These two managed switches have been connected internally ex works with a splice box to which two optical fibers can be connected for each communication network. In addition, a customer communication system can be connected to terminal **LAN 2 Port 4** of the managed switch of the cluster ring.

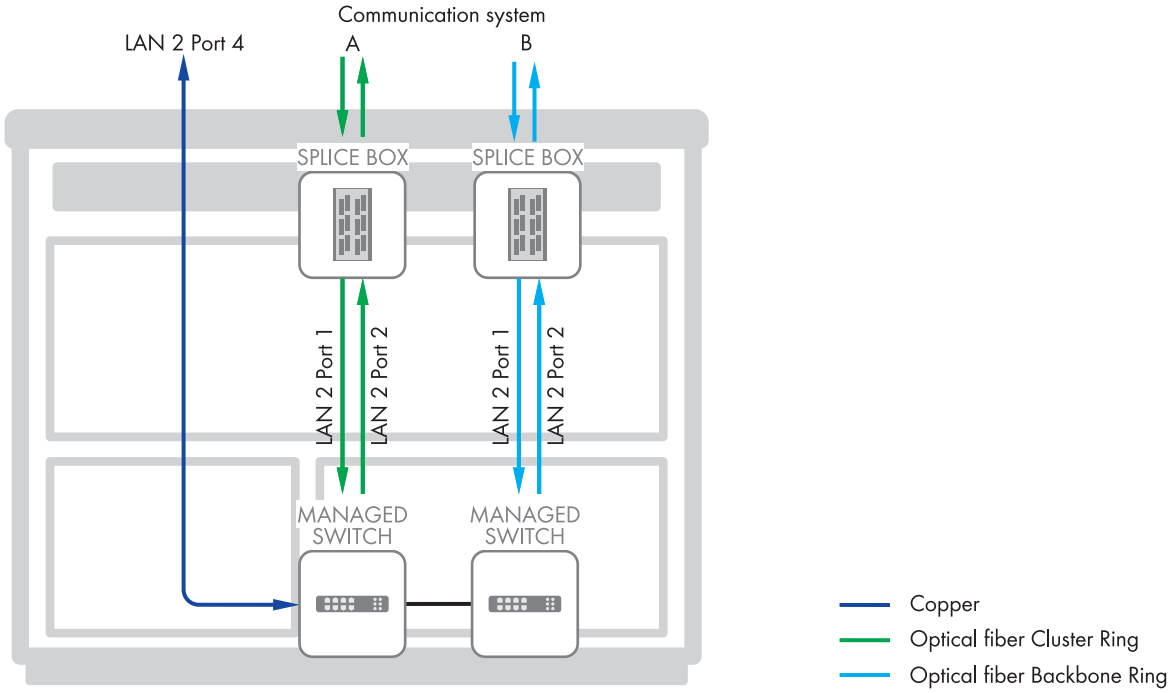


Figure 40: Inverter with two managed switches

In order to guarantee the implementation of control commands, the network that manages the control should be kept free from applications with a high network load, e.g. webcams. Using a separate network is recommended to implement data-heavy applications.

For a stable transmission of Modbus protocols, the frequency of the Modbus requests may not exceed 1/100 ms.

10.5.3 Communication Network in the Customer Communication System

If the inverter does not contain a managed switch, the inverter can be integrated in a PV system with single feeders.

Figure 41: Inverter without managed switch

If the inverter without managed switch is to be integrated in a customer communication system, a switch can be installed in the customer installation location.

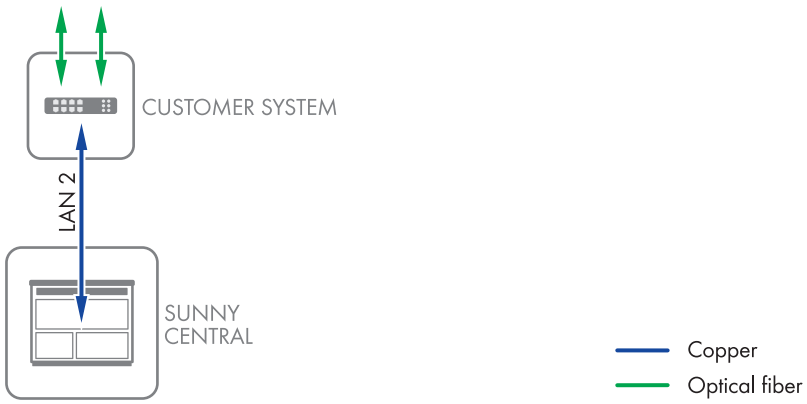


Figure 42: Inverter with customer communication system

In order to guarantee the implementation of control commands, the network that manages the control should be kept free from applications with a high network load, e.g. webcams. Using a separate network is recommended to implement data-heavy applications.

For a stable transmission of Modbus protocols, the frequency of the Modbus requests may not exceed 1/100 ms.

11 Instantaneous Values and Parameters

11.1 Instantaneous Values

11.2 Parameters

No.	Name	Value/range	Default value
305	DclVolSpt	0 V to 2,000 V	850 V
306	GriCod	DE BDEW US IEEE1547 US ERCOT US HECO US NERC US WECC US IESO CAISO US PGE CAISO Custom	–
310	HzRtg	45.00 Hz to 65.00 Hz	50.00 Hz
709	Aid.Mod	Enable Disable	Disable
318	WRtg	0 kW to 5,000 kW	2,200 kW
319	VArRtg	0 kVAr to 5,000 kVAr	1,320 kVAr
323	VARtg	0 kVA to 5,000 kVA	2,200 kVA
730	VADrtPriMod	0 to 1	0
331	RemRdy	Enabled Disabled	Enabled
361	WCtlHzMod	0 to 1	1
362	WCtlHz.DrgIndEna	0 to 1	1
363	WCtlHz.RefMod	W WNom VANom	W
364	WCtlHz.Hz1	0.00 Hz to 65.00 Hz	50.20 Hz
365	WCtlHz.Hz2	0.00 Hz to 65.00 Hz	65.00 Hz
366	WCtlHz.Hz3	0.00 Hz to 65.00 Hz	65.00 Hz
708	WCtlHz.Hz4	0.00 Hz to 65.00 Hz	65.00 Hz
367	WCtlHz.HzGra1	0.00 to 10.00	0.40
368	WCtlHz.HzGra2	0.00 to 10.00	0.00

No.	Name	Value/range	Default value
369	WCtlHz.HzGra3	0.00 to 10.00	0.00
370	WCtlHz.HzStopMin	0.00 Hz to 65.00 Hz	0.00 Hz
371	WCtlHz.HzStopMax	0.00 Hz to 65.00 Hz	50.05 Hz
372	WCtlHz.HzStopTm	0 ms to 1,000,000 ms	0 ms
373	WCtlHz.WGraPosEna	0 to 1	0
374	WCtlHz.WGraNegEna	0 to 1	0
375	WCtlHz.WGraPos	0.00 to 10.00	1.00
376	WCtlHz.WGraNeg	0.00 to 10.00	1.00
377	WCtlHz.HzQtlIntv	0.00 Hz to 0.10 Hz	0.00 Hz
398	WGraReconMod	0 to 1	0
399	WGraRecon	0.00 to 1.00	0.10
424	Frt.LoDb	0.00 to 1.00	0.90
425	Frt.HiDb	1.00 to 1.50	1.10
426	Frt.WaitTm	0.0 s to 20.0 s	0.5 s
427	Frt.LoVolRef1	0.00 V to 1.00 V	1.00 V
428	Frt.LoVolRef2	0.00 V to 1.00 V	0.90 V
429	Frt.LoVolRef3	0.00 V to 1.00 V	0.00 V
430	Frt.LoGra1	0.00 to 10.00	0.00
431	Frt.LoGra2	0.00 to 10.00	2.00
432	Frt.LoGra3	0.00 to 10.00	0.00
433	Frt.HiVolRef1	1.00 V to 2.00 V	1.00 V
434	Frt.HiVolRef2	1.00 V to 2.00 V	1.10 V
435	Frt.HiVolRef3	1.00 V to 2.00 V	2.00 V
436	Frt.HiGra1	0.00 to 10.00	0.00
437	Frt.HiGra2	0.00 to 10.00	2.00
438	Frt.HiGra3	0.00 to 10.00	0.00
441	Frt.AmpDGra	0.0 to 100.0	2.0
444	VCtl.OpMaxNom	0.00 to 2.00	1.05
445	VCtl.OpMinNom	0.00 to 2.00	0.95
446	VCtl.Hi1Lim	0.00 to 2.00	1.15
447	VCtl.Hi2Lim	0.00 to 2.00	1.30

No.	Name	Value/range	Default value
448	VCtl.Hi3Lim	0.00 to 2.00	2.00
449	VCtl.Hi4Lim	0.00 to 2.00	2.00
450	VCtl.Hi5Lim	0.00 to 2.00	2.00
451	VCtl.Hi1LimTm	0 ms to 1,000,000 ms	1,000 ms
452	VCtl.Hi2LimTm	0 ms to 1,000,000 ms	100 ms
453	VCtl.Hi3LimTm	0 ms to 1,000,000 ms	10,000 ms
454	VCtl.Hi4LimTm	0 ms to 1,000,000 ms	10,000 ms
455	VCtl.Hi5LimTm	0 ms to 1,000,000 ms	10,000 ms
456	VCtl.Lo1Lim	0.00 to 2.00	0.80
457	VCtl.Lo2Lim	0.00 to 2.00	0.45
458	VCtl.Lo3Lim	0.00 to 2.00	0.00
459	VCtl.Lo4Lim	0.00 to 2.00	0.00
460	VCtl.Lo5Lim	0.00 to 2.00	0.00
461	VCtl.Lo1LimTm	0 ms to 1,000,000 ms	1,000 ms
462	VCtl.Lo2LimTm	0 ms to 1,000,000 ms	300 ms
463	VCtl.Lo3LimTm	0 ms to 1,000,000 ms	10,000 ms
464	VCtl.Lo4LimTm	0 ms to 1,000,000 ms	10,000 ms
465	VCtl.Lo5LimTm	0 ms to 1,000,000 ms	10,000 ms
466	HzCtl.OpMaxNom	45.00 Hz to 65.00 Hz	50.05 Hz
467	HzCtl.OpMinNom	45.00 Hz to 65.00 Hz	49.95 Hz
468	HzCtl.Hi1Lim	45.00 Hz to 65.00 Hz	51.00 Hz
469	HzCtl.Hi2Lim	45.00 Hz to 65.00 Hz	55.00 Hz
470	HzCtl.Hi3Lim	45.00 Hz to 65.00 Hz	55.00 Hz
471	HzCtl.Hi4Lim	45.00 Hz to 65.00 Hz	55.00 Hz
472	HzCtl.Hi5Lim	45.00 Hz to 65.00 Hz	55.00 Hz
473	HzCtl.Hi6Lim	45.00 Hz to 65.00 Hz	55.00 Hz
474	HzCtl.Hi1LimTm	0 ms to 1,000,000 ms	1,000 ms
475	HzCtl.Hi2LimTm	0 ms to 1,000,000 ms	10,000 ms
476	HzCtl.Hi3LimTm	0 ms to 1,000,000 ms	10,000 ms
477	HzCtl.Hi4LimTm	0 ms to 1,000,000 ms	10,000 ms
478	HzCtl.Hi5LimTm	0 ms to 1,000,000 ms	10,000 ms

No.	Name	Value/range	Default value
479	HzCtl.Hi6LimTm	0 ms to 1,000,000 ms	10,000 ms
480	HzCtl.Lo1Lim	45.00 Hz to 65.00 Hz	49.00 Hz
481	HzCtl.Lo2Lim	45.00 Hz to 65.00 Hz	45.00 Hz
574	HzCtl.Lo3Lim	45.00 Hz to 65.00 Hz	45.00 Hz
483	HzCtl.Lo4Lim	45.00 Hz to 65.00 Hz	45.00 Hz
484	HzCtl.Lo5Lim	45.00 Hz to 65.00 Hz	45.00 Hz
485	HzCtl.Lo6Lim	45.00 Hz to 65.00 Hz	45.00 Hz
486	HzCtl.Lo1LimTm	0 ms to 1,000,000 ms	1,000 ms
487	HzCtl.Lo2LimTm	0 ms to 1,000,000 ms	10,000 ms
488	HzCtl.Lo3LimTm	0 ms to 1,000,000 ms	10,000 ms
489	HzCtl.Lo4LimTm	0 ms to 1,000,000 ms	10,000 ms
490	HzCtl.Lo5LimTm	0 ms to 1,000,000 ms	10,000 ms
491	HzCtl.Lo6LimTm	0 ms to 1,000,000 ms	10,000 ms
492	VCtl.PkLim	0.00 to 2.00	1.30
493	VCtl.PkLimTm	0 to 1,000	6
494	VCtl.Hyst	−0.10 to +0.10	0.002
495	HzCtl.DifMax	0.00 Hz to 50.00 Hz	50.00 Hz
496	HzCtl.DifMaxTm	0 ms to 1,000,000 ms	10,000 ms
497	GriErrTm	0 s to 3,600 s	30 s
512	Mpp.PvVolStrGain	0.20 to 1.00	0.80
733	ErrClr	True False	False
718	Frt.Mod	Disable Full Partial	Disable
645	DrtCabTmp.Mod	0 to 2	1
725	WGraMod	0 to 1	1
726	WGra	0.00 to 100.00	0.20
727	VArGraMod	0 to 1	1
728	VArGra	0.00 to 100.00	0.10
6003	WSptMan	0 kW to 2,500 kW	2,000 kW
6004	WSptFlb	0 kW to 2,500 kW	2,000 kW

No.	Name	Value/range	Default value
6005	VArSptMan	−2,500 kVAr to +2,500 kVAr	0 kVAr
6006	VArSptFlb	−2,500 kVAr to +2,500 kVAr	0 kVAr
6007	PFSptMan	−1.00 to +1.00	1.00
6008	PFSptFlb	−1.00 to +1.00	1.00
6009	GriMng.ComFltFlbVArMod	Error Standby PF PFMeas VAr Last setpoint	Error
6029	PFCtlW.WRef1	0.00 to 1.00	0.00
6030	PFCtlW.WRef2	0.00 to 1.00	1.00
6031	PFCtlW.WRef3	0.00 to 1.00	1.00
6032	PFCtlW.WRef4	0.00 to 1.00	1.00
6033	PFCtlW.WRef5	0.00 to 1.00	1.00
6034	PFCtlW.PFRef1	−1.00 to +1.00	−0.90
6035	PFCtlW.PFRef2	−1.00 to +1.00	0.90
6036	PFCtlW.PFRef3	−1.00 to +1.00	1.00
6037	PFCtlW.PFRef4	−1.00 to +1.00	1.00
6038	PFCtlW.PFRef5	−1.00 to +1.00	1.00
6040	PFCtlW.VolMod	0 to 1	0
6041	PFCtlW.VolDsaPF	−1.00 to +1.00	1.00
6042	PFCtlW.VolEnaVol	0.00 to 2.00	1.050
6043	PFCtlW.VolDsaVol	0 to 2	1
6044	PFCtlW.VolEnaTm	0 ms to 1,000,000 ms	1,000 ms
6045	PFCtlW.VolDsaTm	0 ms to 1,000,000 ms	1,000 ms
6047	VArCtlVol.VolOfs	−10.00 to +10.00	0.00
6048	VArCtlVol.LoVolRef1HiVolRef1	0.00 to 2.00	1.00
6050	VArCtlVol.LoVolRef2	0.00 to 2.00	0.92
6051	VArCtlVol.LoVolRef3	0.00 to 2.00	0.00
6052	VArCtlVol.HiVolRef2	0.00 to 2.00	1.08
6053	VArCtlVol.HiVolRef3	0.00 to 2.00	2.00

No.	Name	Value/range	Default value
6054	VArCtlVol.LoGra1	0.00 to 100.00	0.00
6055	VArCtlVol.HiGra1	0.00 to 100.00	0.00
6056	VArCtlVol.LoGra2	0.00 to 100.00	15.00
6057	VArCtlVol.HiGra2	0.00 to 100.00	15.00
6058	VArCtlVol.LoGra3	0.00 to 100.00	0.00
6059	VArCtlVol.HiGra3	0.00 to 100.00	0.00
6060	VArCtlVol.VArSptFilTm	0.00 ms to 1,000.00 ms	0.50 ms
6061	VArCtlVol.WMod	0 to 1	0
6062	VArCtlVol.WEnaW	0.00 to 1.00	0.50
6063	VArCtlVol.WDsaW	0.00 to 1.00	0.50
6064	VArCtlVol.WEnaTm	0 ms to 1,000,000 ms	1,000 ms
6065	VArCtlVol.WDsaTm	0 ms to 1,000,000 ms	1,000 ms
6074	GriMng.ComFltTmLim	0 s to 86,400 s	300 s
6073	GriMng.ComFltFlbTmLim	0 s to 86,400 s	3,600 s
6071	GriMng.ComFltFlbWMod	Error Standby W Last setpoint	Error
6078	GriMng.WMod	WCtlAnIn WCtlCom WCtlDig WCtlMan Off	WCtlMan
6080	GriMng.VArMod	VArCtlAnIn PFCtlAnIn VArCtlCom PFCtlCom AutoCom VArCtlMan PFCtlMan Off	VArCtlMan
6088	GriMng.InvVArMod	Off VArCtlVol PFCtlW	Off
6091	AmpGraMod	0 to 1	0

No.	Name	Value/range	Default value
6092	AmpRtg	0 A to 10,000 A	3,350 A
6093	AmpGra	0.00 to 100.00	0.20
6095	VolRtg	0 V to 1,000 V	385 V
6109	Frt.VolFilMod	0 to 1	1
6204	HzCtl.PRC024Mod	0 to 1	0
6205	HzCtl.PRC024.Hi1Lim	60.00 Hz to 63.00 Hz	60.50 Hz
6207	HzCtl.PRC024.Hi2Lim	60.00 Hz to 63.00 Hz	62.20 Hz
6209	HzCtl.PRC024.Lo1Lim	57.00 Hz to 60.00 Hz	59.50 Hz
6211	HzCtl.PRC024.Lo2Lim	57.00 Hz to 60.00 Hz	57.80 Hz
6213	HzCtl.PRC024.GainHi	−10.00 Hz to 0.00 Hz	−1.46 Hz
6215	HzCtl.PRC024.OfsHi	0.00 Hz to 1,000.00 Hz	91.1132 Hz
6217	HzCtl.PRC024.GainLo	0.00 Hz to 10.00 Hz	1.7373 Hz
6219	HzCtl.PRC024.OfsLo	−1,000.00 Hz to 0.00 Hz	−100.116 Hz
6310	PvGnd.Mod	Gfdi Gfdi and Bender Remote Gfdi Remote Gfdi and Bender Bender Float Controller and Bender Float Controller Disable	Remote Gfdi
6335	DclVolLim	0 V to 2,000 V	1,150 V
6582	WCtlHz.CfgMod	HzGra W	HzGra
6584	WCtlHz.W2	0.00 to 1.00	0.00
6586	WCtlHz.W3	0.00 to 1.00	0.00
6588	WCtlHz.W4	0.00 to 1.00	0.00
6640	PvGnd.RisIsoWarnLim	0.1 kΩ to 6,553.0 kΩ	50.0 kΩ
6642	PvGnd.RisIsoErrLim	0.1 kΩ to 6,553.0 kΩ	1.0 kΩ
6645	ImpAdpt.Mod	0 to 1	0
6647	ImpAdpt.VARtgMVTrf	0 kVA to 100,000 kVA	2,200 kVA
6649	ImpAdpt.VolNomMVTrf	0.00 to 1.00	0.060
6651	ImpAdpt.ImpRisFacMVTrf	0 to 1,000	5

No.	Name	Value/range	Default value
6653	ImpAdpt.VARtgHVTrf	0 kVA to 1,000,000 kVA	31,500 kVA
6655	ImpAdpt.VolNomHVTrf	0.00 to 1.00	0.161
6657	ImpAdpt.ImpRisFacHVTrf	0 to 10,000	26
6659	ImpAdpt.VArTotCapacHV	0 to 1,000,000	0
6661	ImpAdpt.NumInv	0 to 10,000	1
6672	PFCtlW.VArSptFilTm	0.00 ms to 1,000.00 ms	1.00 ms
6710	Pld.Mod	Enable Disable	Disable
6817	Cnt.Rs	Select counter to reset All counter TotWhOut WhOut WatthIn TotVArOvExt TotVArUnExt TotOpTm TotFeedTm FanStkTm FanCab1Tm FanCab2Tm HtCabTm HtLoExlTmpTm AcSw DcSw1 DcSw2 DcSw3 PrChrgSw CapacSw GfdiTr GfdiSw TotWatthIn DwnTm UpTm	Select counter to reset
6922	WCtlLoHzMod	0 to 1	0
6924	WCtlLoHz.DrgIndEna	0 to 1	0

No.	Name	Value/range	Default value
6926	WCtlLoHz.RefMod	W WNom VANom	W
6928	WCtlLoHz.Hz1	0.00 Hz to 65.00 Hz	59.96 Hz
6930	WCtlLoHz.Hz2	0.00 Hz to 65.00 Hz	59.96 Hz
6932	WCtlLoHz.Hz3	0.00 Hz to 65.00 Hz	0.00 Hz
6934	WCtlLoHz.Hz4	0.00 Hz to 65.00 Hz	0.00 Hz
6936	WCtlLoHz.HzGra1	0.00 to 10.00	0.34
6938	WCtlLoHz.HzGra2	0.00 to 10.00	0.00
6940	WCtlLoHz.HzGra3	0.00 to 10.00	0.00
6942	WCtlLoHz.HzStopMin	0.00 Hz to 65.00 Hz	59.96 Hz
6944	WCtlLoHz.HzStopMax	0.00 Hz to 100.00 Hz	65.00 Hz
6946	WCtlLoHz.HzStopTm	0 ms to 1,000,000 ms	0 ms
6948	WCtlLoHz.WGraPosEna	0 to 1	1
6950	WCtlLoHz.WGraNegEna	0 to 1	1
6952	WCtlLoHz.WGraPos	0.00 to 10.00	1.00
6954	WCtlLoHz.WGraNeg	0.00 to 10.00	1.00
6956	WCtlLoHz.HzQtlIntv	0.00 Hz to 1.00 Hz	0.00 Hz
6958	WCtlLoHz.CfgMod	HzGra W	HzGra
6960	WCtlLoHz.W2	1.00 to 100.00	10.00
6962	WCtlLoHz.W3	1.00 to 100.00	10.00
6964	WCtlLoHz.W4	1.00 to 100.00	10.00
6989	VCtl.OvVolConMod	0 to 1	0
6991	VCtl.OvVolConLim	0.00 to 2.00	1.20
6993	VCtl.OvVolConOpnTm	0 ms to 100,000 ms	0 ms
6995	VCtl.OvVolConClsTm	0 ms to 100,000 ms	500 ms
7024	UtlznHght	Custom 1000 m 2000 m 3000 m 4000 m	–
7048	PvGnd.AcIsoMonTm	0.1 s to 86,400.0 s	60.0 s

12 Appendix

12.1 Measurement accuracy

The inverter is not equipped with a calibrated meter. The display values may deviate from the actual values and must not be used as a basis for invoicing. The inverter's measured values are required for the system management and to control the current to be fed to the grid.

Deviation:

- Voltage measurement: ± 5 V
- Frequency measurement: ± 0.06 Hz
- Disconnect time: ± 0.1%

12.2 Requirement on the overall system

☐ When designing the components of the PV system, you should take account of the maximum inrush current.

☐ During configuration, you should take account of the fact that the closed-loop control of the compensation plant on the MV side does not affect the closed-loop control of the inverter.

☐ During configuration of the PV system, the scale times of the various MV switchgear must be coordinated with each other. This means that only PV systems, in which a disturbance has occurred, are disconnected from the utility grid.

12.3 Structure of names for parameters and instantaneous values

The names of parameters and instantaneous values are allocated over the entire system according to a standardized concept. Accordingly, the names are made up of acronyms as defined in the standard IEC61850.

In general, a name looks like this: **Modulecode.Namepart1.Namepart2**

- A name can consist of several parts each separated by a period. A name can consist of up to three parts.
- Parameters and instantaneous values made up of just one part pertain to the entire inverter.
- The name begins with the module code to which the parameter or instantaneous value refers. As a result, those parameters and instantaneous values belonging e.g. to one process or one hardware component are grouped.
- A part of a name can consist of several acronyms which together describe what the parameter or instantaneous value represents. The names are organized according to a tree structure.

The main module acronyms are explained below:

Module acronym	Description
Cnt	Energy meter for different instantaneous values
DcMs	Monitoring of the DC values
Frt	Parameters for grid support
GriMng	Parameters for grid management services
GriMs	Monitoring of the utility grid
HzCtl	Parameters for monitoring the power frequency
InvMs	Monitoring of the AC values in the inverter
Mpp	Parameters for MPP tracking
PFCtlW	Parameters for power-dependent reactive power control

Module acronym	Description
VArCtlVol	Parameters for voltage-dependent reactive power control
VCtl	Parameters for monitoring the grid voltage
WCtlHz	Parameters for frequency-dependent active power control

12.4 Information on Data Storage

The internal memory of the inverter can store the following data:

Type of data	Memory size
Events	10,000 entries in the ring buffer
Measured values	Max. 1,000 data points per second

The communication interface is delivered with a permanently installed CF memory card. Updates, events, measured values and export files, for example, can be stored on the CF memory card. 2 GB are available for this.

12.5 Reaction Speed of the Modbus Control

In order to meet the specifications of the electric utility company, the inverter must observe a particular reaction speed when implementing control commands via Modbus.

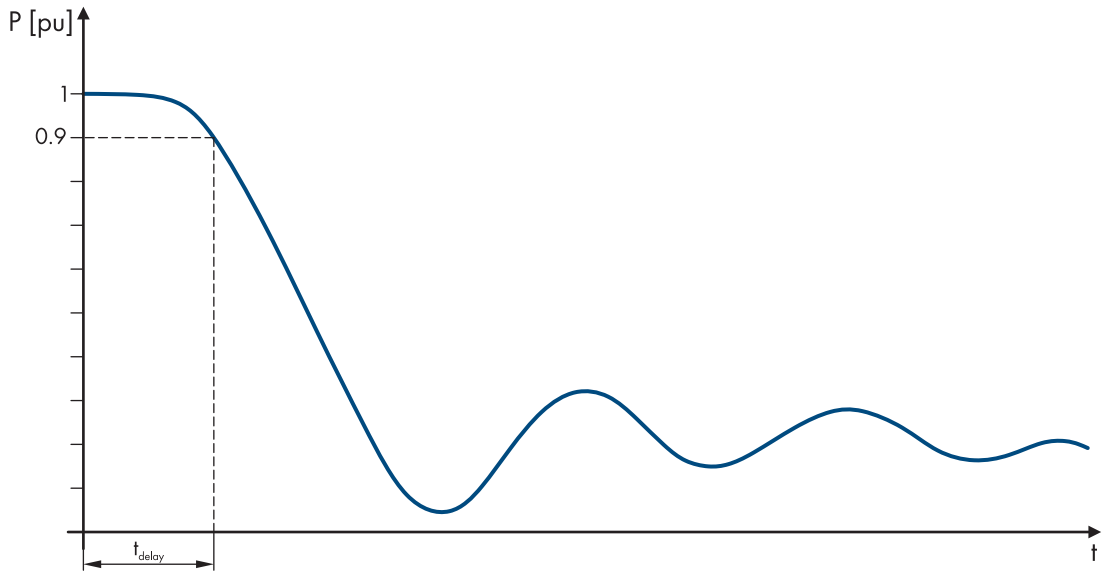


Figure 43: Reaction speed of the Modbus commands in the inverter

The reaction time T_{delay} is the time that the inverter requires to change the power on the AC side of the inverter by ten percent towards the new output value after having received a Modbus control command. The ten percent refer to the difference between the old and the new output value.

13 Contact

If you have technical problems with our products, please contact the SMA Service Line. We need the following information in order to provide you with the necessary assistance:

- Device type
- Serial number
- Type and number of PV modules connected
- Type of communication
- Error number and error message

United States/ Estados Unidos	SMA Solar Technology America LLC Rocklin, CA	Toll free for USA, Canada and Puerto Rico / Llamada gratuita en EE. UU., Canadá y Puerto Rico: +1 877-MY-SMATech (+1 877-697-6283) International / Internacional: +1 916 625-0870
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